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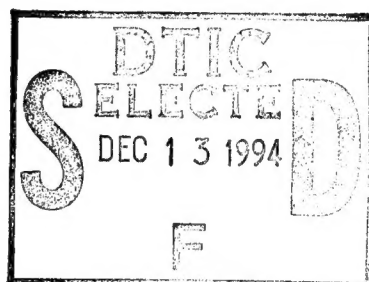
Analysis of Special Operations Forces in Decision Aids: Current Shortfalls

Bruce Pirnie, Margaret C. Harrell

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Bruce Pirnie, Margaret C. Harrell

**Prepared for the
Commander in Chief,
  U.S. Special Operations Command
Joint Staff**

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PREFACE

This Note records work accomplished during Phase 1 of the project Analysis of Special Operations Forces Decision Aids. The objective of this project is to recommend ways in which the capabilities and contributions of special operations forces (SOF) can be better represented in decision aids that support the defense planning, programming, and budgeting process. Phase 1 included two tasks. Task 1 required RAND to discern the issues central to SOF analysis. The results of Task 1 were briefed to U.S. Special Operations Command (USSOCOM) staff in October 1991. They are presented here in a condensed form. Task 2 required RAND to identify current analytic shortfalls. This effort was supported by a survey of the Office of the Secretary of Defense, the Joint Staff, analytic agencies supporting the Service staffs, and military educational institutions. These organizations were chosen for their official connections to resource allocation decisions. The results of Task 2 were briefed to USSOCOM staff in April 1992.

This Note should be of interest to persons concerned with special operations and military modeling.

This work was performed within the International Security and Defense Strategy Program of RAND's National Defense Research Institute (NDRI), a federally funded research and development center sponsored by the Office of the Secretary of Defense and the Joint Staff. Comments should be directed to the authors or to Dr. Charles Kelley, Director of the International Security and Defense Strategy Program.

SUMMARY

The Office of the Secretary of Defense, the Joint Staff, analytic agencies supporting the Service staffs, and military educational institutions support the defense planning, programming, and budgeting process with a variety of automated decision aids. Based on a survey of these organizations, we conclude that currently used decision aids cover Special Operations Forces (SOF) missions inadequately:

- Counterterrorism is not covered.
- Special reconnaissance is partially covered by some models, except that beach reconnaissance is only scripted.[1]
- Direct action is partially covered by some models, except that recovery of personnel and material is not covered.
- Unconventional warfare is not covered.
- Foreign internal defense is partially covered by two models offering extremely different perspectives.

The combat models encountered in our survey range from tactical level to theater level as shown in Figure S.1 below. The tactical-level models allow simulation of some tasks included in the special reconnaissance and direct action missions. They do not allow consideration of effects above tactical level that are critically important for resource allocation decisions affecting SOF. To consider these effects, a model must include theater-level operations. In our survey of the organizations described above, we encountered three broad categories of theater-level models: interactive exercise drivers, semi-autonomous models, and autonomous, piston-style models. An exercise driver is designed to support command post exercises. It requires extensive human interaction and provides rapid adjudications of combat without much concern for analytic validity. A semi-autonomous model is designed to run interactively until the operator is satisfied that he has identified key issues. Thereafter, a semi-autonomous model may be run iteratively to support analysis. An autonomous model is designed to run without human interaction although some interaction may be allowed. Piston style implies that maneuver is restricted to advance or retreat on a major axis according to adjudication of combat.

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[1]An operator "scripts" events by superimposing them on the autonomous adjudication routines.

Theater-level combat: interactive exercise drivers	Contingency Force Analysis Wargame (CFAW) Corps Battle Simulation/Joint Exercise Support System (CBS/JESS) Joint Theater Level Simulation (JTLS)	
Theater-level combat: semi-autonomous models	Eagle Integrated Theater Engagement Model (ITEM) Current Theater Level Simulation (CTLS) RAND Strategy Assessment System-Integrated Theater Model (RSAS-ITM)	
Theater-level combat: autonomous, piston-driven models	Concepts Evaluation Model (CEM) Tac Thunder Tactical Warfare (TACWAR) [Theater Assessment Model (TAM)]*	*Although piston-driven, TAM is currently a highly interactive model.
Taskforce-level combat	Joint Conflict Model (JCM) Enhanced Naval Wargame System (ENWGS) Tactical Warfare Simulation, Evaluation, & Analysis System (TWSEAS)	
Tactical-level combat	Security Exercise Evaluation Simulator (SEES) Janus	

Figure S.1—Models by Category

We evaluated nine mature theater-level models in three areas: relevance to special operations, degree of acceptance, and viability as shown in Figure S.2 below. A model's relevance to SOF correlates poorly with the model's acceptance. Several models with low relevance have high acceptance, while some semi-autonomous models with high relevance have low acceptance. There is much better correlation between relevance and viability: No model with high relevance has low viability. This correlation suggests that a model that is sufficiently sophisticated to address SOF issues is likely to be technically advanced and user friendly as well. However, high viability does not imply high relevance: A deliberately simple model built for other purposes may fail to address SOF entirely.

Our evaluation revealed a fundamental dilemma for those SOF missions best covered by current models, i.e., special reconnaissance and direct action. Broadly stated, interactive exercise drivers are most relevant and currently provide the best coverage. Semi-autonomous models are moderately relevant, while autonomous, piston-style models are least relevant. However the interactive exercise drivers are unsuited to the iteration typically required to analyze capabilities. If one considers the current degree of acceptance, the dilemma becomes more complex. The exercise drivers and the autonomous, piston-style models are widely accepted and used, the former to drive exercises and the latter to analyze capabilities. Semi-autonomous models, including some just emerging from development,

Relevance to special operations:	Acceptance:	Viability:

• Operational level of war
• Joint and combined forces
• C3I
• Movement and maneuver
• Unconventional warfare
• Political, economic, and social factors
	• Agreement with
	  — Service doctrine
	  — Actual events
	• Accreditation
	  — De jure (official)
	  — De facto (use)
		• Technical freshness
		  — Language
		  — Architecture
		• Transparency
		• User friendliness
		  — Ease in learning
		  — Ease of startup
		  — Character of interface
		• Adaptation to post-1989

How well does this model address areas of SOF effect?	What agencies currently accept this model?	How appropriate is this model for widespread use?

Figure S.2—Evaluation Methodology

might offer a middle way between these extremes, but these do not currently enjoy wide acceptance. Thus, no category of theater-level models combines at least moderate relevance to SOF issues, wide acceptance, and suitability for iterative use.

There is little prospect that interactive exercise drivers will be able to support iterative analysis. There is no short-term prospect that the autonomous, piston-style models will become more relevant to special reconnaissance and direct action. We have no basis to predict how well the newer semi-autonomous models will emerge from continuing development or how widely they will be accepted. However, as military modeling adapts to the post-1989 security environment, it should become increasingly more useful for addressing such topics as command and control, intelligence, maneuver warfare, deep fires, and the disparate qualities of national forces. Many of these topics are also associated with special operations.

ACKNOWLEDGMENTS

CONTENTS

FIGURES

ACRONYM LIST

ACES	Air Force Command Exercise System
ACSC	Air Command and Staff College
AFSAA	Air Force Studies and Analyses Agency
AFWC	Air Force Wargaming Center
AGILE	Air, Ground, Intelligence, Logistics Exercise
ATCAL	Attrition Model Using Calibrated Parameters
ATO	Air Tasking Order
AU	Air University
AWACS	Airborne Warning and Control System
AWSIM	Air War Simulation
BBS	Battalion Battle Simulation
BCTP	Battle Command Training Program
C3	Command, Control, Communications
C3I	Command, Control, Communications, and Intelligence
CA	Civil Affairs
CAA	U.S. Army Concepts Analysis Agency
CAC	Combined Arms Command
CASCON III	Computer-Aided System for Analysis of Local Conflicts
CASES	Computer Assisted Staff Exercise Simulation
CATA	Combined Arms Training Activity
CBAM	Combat Base Assessment Model
CBS	Corps Battle Simulation
CEM VI	Concepts Evaluation Model VI
CEP	Combat Events Program
CFAD	Conventional Forces Analysis Division
CFAW	Contingency Force Analysis Wargaming
CFE	Conventional Forces in Europe
CIA	Central Intelligence Agency
CINC	Commander-in-Chief
CINCPACFLT	Commander-in-Chief Pacific Fleet
CLIC	Army-Air Force Center for Low Intensity Conflict
CNA	Center for Naval Analyses
CNWS	Center for Naval Warfare Studies
COA	Courses of Action
COBRA	Combat Outcome Based on Rules for Attrition
COEA	Cost and Operational Effectiveness Analysis
COSAGE	Combat Sample Generator
CPX	Command Post Exercise
CRES	Command Readiness Exercise System
CSC	Computer Science Corporation
CSCE	Conference on Security and Cooperation in Europe
CT	Counterterrorism
CTLS	Current Theater-Level Simulation
DA	Direct Action
DEAC	Division through Echelons Above Corps Division
DMSO	Defense Modeling and Simulation Office
EADSIM	Extended Air Defense Simulation
ENWGS	Enhanced Naval War Gaming System

FAMSIM	Family of Simulations
FDD	Force Design Division
FFRDC	Federally Funded Research and Development Center
FID	Foreign Internal Defense
FLOT	Forward Line of Own Troops
FORCEM	Force Evaluation Model
FORTRAN	Formula Translating Systems
FPM	Force Planning Model
FTX	Field Training Exercise
FVC	Force Value Calculator
GASs	Ground Attack Sorties
GRWSIM	Ground War Simulation
GWG	Global War Game
HUMINT	Human Intelligence
IDA	Institute for Defense Analyses
IDAD	Internal Defense and Development
IMT	Information Management Terminal
ITEM	Integrated Theater Engagement Model
JCM	Joint Conflict Model
JESS	Joint Exercise Support System
JLASS	Joint Land, Aerospace, and Sea Simulation
JPL	Jet Propulsion Laboratory
JS	Joint Staff
JTLS	Joint Theater Level Simulation
JWC	Joint Warfare Center
LIC	Low Intensity Conflict
LICAWS	Low Intensity Conflict Analysis Workshop
LISP	List Processing Language
MAPP	Modern Aids to Planning Program
MCCDC	Marine Corps Combat Development Command
MCR	MAPP Change Request
MEB	Marine Expeditionary Brigade
MEF	Marine Expeditionary Force
Metric VI	Theater-Level Simulation of Air-Land-Sea Combat
MEU-SOC	Marine Expeditionary Unit-Special Operations Capable
MISMA	Model Improvement and Study Management Agency
MOD	Ministry of Defense
NAVWAR	Naval Warfare
NCC	Naval Command College
NDRI	National Security Research Institute
NDU	National Defense University
NoREDs	Gaming Nonreduction Measures
NPS	Naval Postgraduate School
NSC	National Simulation Center
NSIA	National Security Industrial Association
NWARS	National Wargaming System
NWC	Naval War College
NWPAC	Northwest Pacific
NXG	Next Generation Wargame
OPFOR	Opposing Force
OPLAN	Operations Plan
OSD	Office of the Secretary of Defense

OSD/NA	Office of the Secretary of Defense/Net Assessment
PA&E	Program Analysis and Evaluation
PBAD	Program Budget and Analysis Division
PC	Personal Computer
PM Trade	Program Manager, Training Devices
PMAD	Politico-Military Assessment Division
POM	Program Objective Memorandum
PPBS	Planning, Programming, and Budgeting System
PSYOPS	Psychological Operations
RDSS	Regional Development Simulation System
RSAS	RAND Strategy Assessment System
RSAS ITM	RAND Strategy Assessment System-Integrated Theater Model
RSP	Rapid Scenario Processor
SAIC	Science Applications International Corporation
SDS	Scenario Development System
SEACON	Sea Control
SEAL(s)	(U.S. Navy) Sea Air Land (teams)
SEES	Security Exercise Evaluation Simulator
SHAPE	Supreme Headquarters, Allied Powers Europe
SIMNET	Simulation Network
SLIC	Simulated Low-Intensity Conflict
SO/LIC	Special Operations/Low Intensity Conflict
SOF	Special Operations Forces
SORDAC	Special Operations Research, Development, and Acquisition Center
SOUTHCOM	Southern Command
SPAWAR	Space and Naval Warfare Systems Command
SR	Special Reconnaissance
SUWAM	Strategic Unconventional Warfare Assessment Model
SWC	Scenario Wargaming Center
TAC RAM	TAC Resource Allocation Model
TACSIM	Tactical Simulator
TACTRAGRULAN	Tactical Training Group Atlantic
TACTRAGRUPAC	Tactical Training Group Pacific
TACWAR	Tactical Warfare (Model)
TAM	Theater Analysis Model
TRAC	TRADOC Analysis Command
TRADOC	Training and Doctrine Command
TWSEAS	Tactical Warfare Simulation, Evaluation, and Analysis System
TWSEAS-M	Tactical Warfare Simulation, Evaluation and Analysis System-Modified
UCCATS	Urban Combat Computer Assisted Training System
USA	United States Army
USAF	United States Air Force
USAWC	U.S. Army War College
USCENTCOM	U.S. Central Command
USEUCOM	U.S. European Command
USLANTCOM	U.S. Atlantic Command
USN	United States Navy
USPACOM	U.S. Pacific Command
USSOCOM	U.S. Special Operations Command
USSOUTHCOM	U.S. Southern Command
UW	Unconventional Warfare
VAX	Virtual Address Extension

VIC	Vector in Commander
WARSIM	Warfighters Simulation
WPC	Warrior Preparation Center
WWII	World War II

1. INTRODUCTION

BACKGROUND

The Office of the Secretary of Defense, the Joint Staff, analytic agencies supporting the Service staffs, and military educational institutions use a variety of automated decision aids to support analysis of budgets, operational plans, and military capabilities. However, these decision aids inadequately represent special operations forces (SOF). In some instances, SOF are inadequately represented because their capabilities cannot be quantified or expressed in parameters at the current level of resolution. In other instances, the methodologies inherent in the decision aids fail to include the full spectrum of SOF missions at any level of resolution. These inadequacies may lead to ignorance of SOF capabilities and cause neglect of SOF in the decisionmaking process. In the current state of the art, no model captures the full range of SOF missions across the continuum of peacetime, conflict, and war. Therefore, a better representation of SOF will likely require some modification of existing decision aids and newly created aids.

SPECIAL OPERATIONS FORCES DECISION AIDS PROJECT

This project proceeds according to a logical succession of related tasks. In Task 1, RAND discerned the issues critical to SOF analysis. To this end, we characterized the full range of missions, addressing: (1) the nature of the mission, (2) inputs affecting accomplishment of the mission, and (3) measures of success or failure. The results of Task 1 appear in highly condensed form in Sections 2 and 3 of this Note. In Task 2, RAND conducted a survey of SOF analysis with emphasis on computer-assisted decision aids. The results of Task 2 appear in Sections 4 through 8 of this Note. In Task 3, RAND will develop a construct to assist analysts concerned with SOF. This construct will detail SOF capabilities, the factors relevant to success, and the parameters of mission performance. It will also divide SOF missions into categories defined by the prospects of capturing these missions in either currently existing or new models. In Task 4, RAND will recommend modifications to decision aids or creation of new aids to better represent SOF. The timeline for this project is shown in Figure 1.1 below.
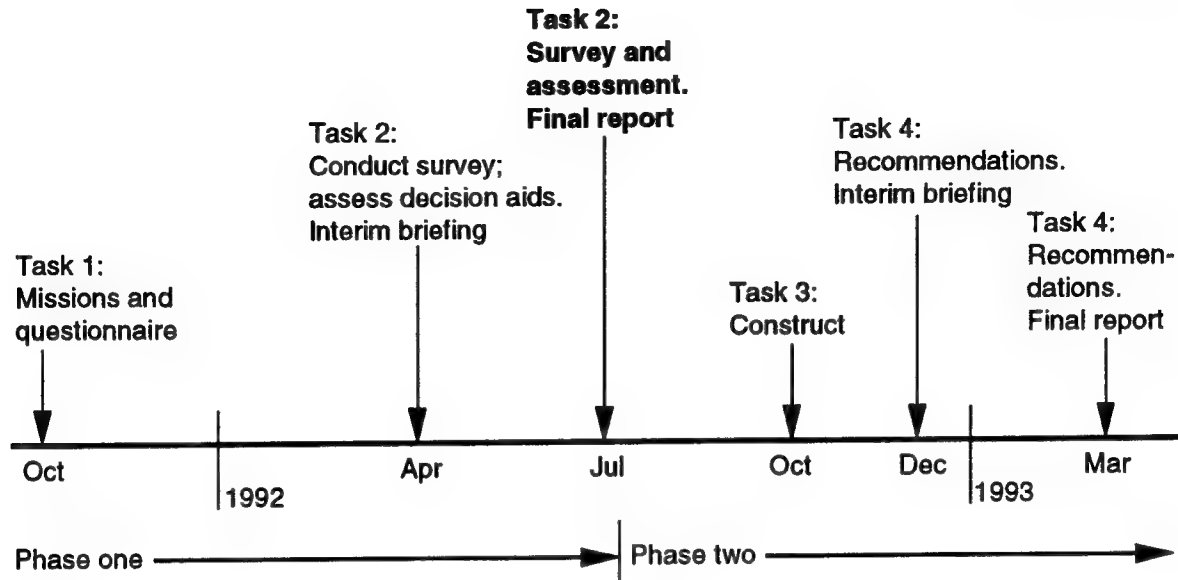
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Figure 1.1—Project Timeline

2. MISSIONS OF SPECIAL OPERATIONS FORCES

The 1986 Goldwater-Nichols Defense Reorganization Act directed creation of U.S. Special Operations Command (USSOCOM), which was formed the following year at MacDill Air Force Base, Tampa, Florida. USSOCOM is a unified command that includes components from the Army, Air Force, and Navy. (See Appendix A for current USSOCOM forces grouped by Service component.) USSOCOM is responsible for the training, equipment,[1] and readiness of all special operations forces. Depending upon circumstances, the commander-in-chief of USSOCOM may have operational control of SOF or he may provide them to another unified command. SOF are light forces that undergo exceptionally strenuous training and maintain a variety of specialized skills. Some of their equipment is substantially modified from standard issue or specially procured.

According to current U.S. doctrine, SOF have five basic missions: counterterrorism (CT), special reconnaissance (SR), direct action (DA), unconventional warfare (UW), and foreign internal defense (FID).[2] While each of the five basic missions is distinct in a doctrinal sense, they may overlap during actual operations. For example, SOF conducting reconnaissance may simultaneously perform direct action.

COUNTERTERRORISM

SOF apply specialized capabilities to resolve or preempt terrorist incidents abroad. Civilian agencies will normally exercise primary responsibility for incidents within the United States, while the military takes the lead abroad. CT resolves into two tasks: (1) hostage rescue and recovery of material, and (2) attack on terrorist infrastructure. A famous example of hostage rescue is the ill-fated attempt to free U.S. hostages in Tehran during April 1980.[3] Another example is the *Achille Lauro* incident in October 1985. As an example of recovery operations, SOF might try to recover military materiel, such as sophisticated weapons or weapons of mass destruction, which had fallen into the hands of terrorists.

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[1]USSOCOM exercises this responsibility through the U.S. Special Operations Research, Development, and Acquisition Center (SORDAC), which oversees programs managed by the Services and manages some programs directly.

[2]Material in this section is condensed from material reviewed and corrected by members of USSOCOM staff before publication per Memorandum, U.S. Special Operations Command, S0J7-S, Subject: Questionnaire and Characterization of SOF Missions, 21 Nov 91. However, the authors are responsible for any errors.

[3]The hostage rescue attempt in Iran is categorized here as counterterrorism because the perpetrators were not official agents of the Iranian government. However, the Iranian government protected and encouraged the hostage takers to such an extent that the rescue attempt might be considered direct action.

Rescue and recovery are reactive, while attack on terrorist infrastructure carries the war to the enemy. The tactics and techniques associated with CT are often classified in order to deny advantages to prospective terrorists.

SPECIAL RECONNAISSANCE

SOF conduct SR to gain data of critical significance in hostile or politically sensitive territory. The SR mission resolves into four illustrative tasks: (1) geographic and hydrographic reconnaissance, (2) target acquisition, (3) post-strike reconnaissance, and (4) reconnaissance directed against conventional forces. Geographic reconnaissance may include the acquisition of soil samples to determine trafficability for heavy tracked vehicles, as was done prior to the flanking operations conducted by VII Corps during Operation Desert Storm. Hydrographic or beach reconnaissance is usually performed by U.S. Navy Sea Air Land (SEAL) teams in preparation for an amphibious assault. A recent example of target acquisition is the use of SOF to locate Iraqi extended range SCUD missiles during Operation Desert Storm.[4] Post-strike reconnaissance involves assessing damage against a previously engaged target and may merge into strike reconnaissance. SOF conduct conventional force reconnaissance against opposing air, land, or sea forces, often through insertion near a chokepoint, such as a defile or strait. An example is the insertion of small SOF teams in the Euphrates Valley during Operation Desert Storm to observe Iraqi forces operating on the left flank of VII Corps.

DIRECT ACTION

SOF conduct DA in team- through multi-battalion-size to accomplish critical tasks, often out of contact with friendly forces. DA resolves into three tasks: (1) destruction of key targets, (2) occupation of key facilities, and (3) capture or recovery of personnel and materiel. As an example of the first task, SOF MH-53J Pave Low helicopters led attack helicopters to Iraqi radar sites at the onset of the air campaign in Desert Storm.[5] Other targets might include communication nodes, command posts, and high-value systems, such as mobile

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[4]Benjamin F. Schemmer, "Special Ops Teams Found 29 Scuds Ready to Barrage Israel 24 Hours Before Ceasefire," *Armed Forces Journal International*, July 1991. See also Douglas Waller, "Secret Warriors," *Newsweek*, June 17, 1991. *Conduct of the Persian Gulf War, Final Report to Congress*, Pursuant to Title V of The Persian Gulf Conflict Supplemental Authorization and Personnel Benefits Act of 1991, Public Law 102-25, Department of Defense, April 1992, (hereafter *Conduct of the Persian Gulf War*), confirms SOF reconnaissance against SCUD in general terms: "A key element in this effort [SCUD hunting] was small SOF groups on the ground who provided vital information about the Scuds" (p. 224). This report does not, however, confirm the dramatic success described in Schemmer's article.

[5]Richard Mackenzie, "Apache Attack," *Air Force Magazine*, October 1991; Benjamin F. Schemmer, "USAF MH-53J Pave Lows Led Army Apaches Knocking Out Iraqi Radars to Open Air War," *Armed Forces Journal International*, July 1991. See also *Conduct of the Persian Gulf War*, Appendix J, pp. J-12 to J-13 and Waller, 1991.

ballistic missiles. Despite their limited combat power, SOF may occupy and hold key facilities pending linkup with larger conventional forces. For example, during Operation Urgent Fury in October 1983, elements of two Ranger battalions held Salines Airport to facilitate deployment of two brigades from the 82nd Airborne Division. The third task might entail the attempted recovery of prisoners of war held within enemy territory, as in the well-known Son Tay raid in North Vietnam on November 19, 1970.[6] Another example is the recovery of the Governor General of Grenada, Sir Paul Scoon, during Operation Urgent Fury.[7]

UNCONVENTIONAL WARFARE

SOF may assist an insurgency against an occupying power or government. UW includes these elements: intelligence collection, escape and evasion, subversion, sabotage, and guerrilla warfare. Historical examples include allied assistance to French maquis and Yugoslav partisans during WWII. A more recent example might be assistance to the rebel tribesmen or mujahideen during the recent Soviet occupation of Afghanistan. When conducting UW, SOF enjoy the guerrilla's advantage of choosing the time and place to attack. They typically break off contact before combat becomes large scale or protracted. They also have the additional advantage of having little responsibility for the security of populations. On the contrary, they may find it useful to play a largely destructive role by attacking government forces and damaging infrastructure that supports government control.

FOREIGN INTERNAL DEFENSE

SOF may assist paramilitary and military forces of a host government to provide a secure environment. The full FID mission implies establishing a secure environment and ameliorating the causes of internal instability. Normally, FID is an inter-agency activity with the military in a supporting role. FID includes: intelligence collection, civic and humanitarian action, training host forces, interdiction of insurgent routes, and destruction of insurgent bases and forces. The Vietnam conflict is an important example of FID in American experience. During that conflict, SOF were heavily involved in civic action programs that included vocational training, education, transportation, building projects, and medical care. U.S. Army Special Forces (SF) trained and led Montagnard troops, including the mobile strike ("Mike") forces. SOF also conducted extensive long range patrolling to interdict insurgencies.

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[6]See Benjamin F. Schemmer, *The Raid*, Harper and Row, 1986.
[7]See Kevin Dockery, *SEALS in Action*, Avon Books, 1991, pp. 257–271, and Richard Marcinko, *Rogue Warrior*, Simon & Schuster, 1992, pp. 277–281.

ADDITIONAL ACTIVITIES

In addition to the basic missions, SOF conduct a variety of activities for which they are especially suited. These include personnel recovery (search and rescue), counterdrug operations, antiterrorism, humanitarian action, and security assistance. Antiterrorism comprises actions taken to reduce U.S. or an ally's vulnerability to terrorist threats. Humanitarian action often takes the form of disaster relief or aid to refugees, such as aid given to the Kurdish population following Operation Desert Storm. Training indigenous personnel is the primary role of SOF in security assistance. SOF are especially well suited to this role because of their experience in foreign environments and their language proficiency. SOF also conduct psychological operations (PSYOPS)[8] and civil affairs (CA)[9].

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[8]PSYOPS involve conveying information to foreign audiences to influence opinions, emotions, attitudes, and ultimately behavior in ways that contribute to U.S. objectives. PSYOPS employ loudspeakers, print media, radio, and television in support of special operations and conventional forces from tactical to strategic level.

[9]CA includes the identification of local resources that a commander may require to accomplish his objectives, coordination between civil and military authorities to obtain these resources, and measures to minimize interference between military operations and civilian activities.

3. ISSUES CRITICAL TO ANALYSIS OF SPECIAL OPERATIONS FORCES

Analysis of special operations poses different demands from analysis of conventional operations. Analysis of conventional operations normally applies stereotyped measures of success: forward line of own troops (FLOT) movement, which may translate to territory gained or lost, and attrition of enemy and friendly forces. These measures do not apply to special operations or they apply as extended or as ultimate effects within an operational context.

COMMON ISSUES

Importance of Extended and Ultimate Effects

Useful distinctions may be made among the immediate, extended, and ultimate effects[1] of SOF actions. For example, SOF might sever a communications cable in the opposing rear area. An immediate effect would simply be loss of that communications link until it could be repaired or indefinitely if the action were repeated. An extended effect might be degradation of command and control depending upon the amount of redundancy in the enemy communications net. More subtle, it might be an improvement in friendly intelligence if the enemy were compelled to use radio transmissions that were less secure. An ultimate effect might be confusion and helplessness spreading through the enemy's command structure.

In some instances, the immediate effect may have little military significance, while the extended and ultimate effects are extremely important. To take a dramatic example, the Iraqi extended range SCUD missiles employed during Desert Storm had little military utility. In this sense, their destruction was inconsequential except in demonstrating U.S. capabilities. But the primary purpose of SCUD attacks was to provoke Israel into entering the war, thus changing the war's character. Seen from this perspective, SOF target acquisition[2] against Iraqi SCUDs may have had strategic consequences. Using the same framework, destruction and suppression of SCUD missiles was an immediate effect. Israeli perception that the United States was attacking SCUDs effectively or at least making all

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[1]These effects might also be described as "first, second, and third order," analogous to mathematical usage.

[2]See Benjamin F. Schemmer, "Special Ops Teams Found 29 Scuds Ready to Barrage Israel 24 Hours Before Ceasefire," *Armed Forces Journal International*, July 1991, for an account of dramatic success by SOF. If SOF did not in fact enjoy such dramatic success, their SCUD reconnaissance might still have had an extended effect by helping to convince the Israelis that the United States was employing all possible means to locate and destroy the mobile launchers.

possible efforts to destroy them was an extended effect. Israeli neutrality and a stable anti-Iraq coalition were the ultimate effects.

Above the Tactical Level

Because their strength does not exceed a few battalions, SOF work at the tactical level. However, their effects are felt at higher levels. Almost any example drawn from recent experience will serve to make this point. During Urgent Fury, the Rangers' seizure of Salines was crucial to the campaign because it provided an airport to support the rapid deployment of overwhelming force. In other words, the tactical employment of SOF had operational significance for non-SOF, in this case the 82nd Airborne Division. To take an example from unconventional warfare, mujahideen interdiction of supply columns hampered the Soviet occupation forces in Afghanistan and diverted Soviet combat forces to highway security. In this way, small actions at the tactical level had operational consequences. This general principle defines the leverage SOF can provide and justifies maintaining unique, sometimes costly forces with special capabilities. The implication for analysis is obvious: Any attempt to comprehend the effect of SOF must extend above the tactical level. It must encompass the operational and even strategic level of war, which may require inclusion of large conventional forces in the analysis.

ISSUES BY MISSION

Counterterrorism Dominated by Uncertainty

Analysis of counterterrorism (CT) is dominated by uncertainties. Intelligence that will be available at crucial times, assistance from host countries, political constraints on U.S. reaction, and the terrorist threat are uncertain elements. How, for example, could the Red Army Faction ("Baader-Meinhof") emerge from an affluent, peaceful West German society? In addition, the tactics and techniques of forces that conduct CT must be protected if they are to be effective.[3] For this reason, few agencies will normally have access to the data required for analysis of CT on the tactical level. The immediate effects of CT are the recovery of hostages and materiel or the destruction of terrorist infrastructure. While these effects may be important in themselves, they are usually less important than an extended effect: containment and diminution of terrorism. There is also an ultimate effect: the expectation,

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[3]"Counterterrorism is a doctrinal mission for Special Forces. It is a mission that our units are trained and equipped to perform. In order for our units to be effective should they ever be called upon to perform such a mission, it is important to protect their tactics, techniques and procedures. As a result, it is not an area that we can talk a great deal about." Lieutenant General Wayne A. Downing, Commander, U.S. Army Special Operations Command, in "A Force of 'Great Utility' That Cannot Be Mass-Produced," *Army*, April 1992, p. 33.

especially within the affected populations, that the United States can and will combat terrorism effectively. This ultimate effect is of ultimate importance, but it is difficult or impossible to quantify.

Special Reconnaissance and Direct Action Analyzed at the Task Level

These two missions must be analyzed at the level of the illustrative, stand-alone tasks mentioned in Section 2. These tasks vary from one another in the steps to be performed, the input variables affecting success, and especially in the extended and ultimate effects. For example, hydrographic reconnaissance is affected by the insertion method, usually employing boats or unique submersibles, and the environment, including sea state, tides, gradients, obstacles, and beach conditions. The risk of detection is critically dependent on the sea control exerted by friendly forces. The immediate effect is an improvement in U.S. intelligence concerning the prospective landing area. The extended effect concerns the landing itself, and the ultimate effect involves the impact of the landing on the wider campaign. By contrast, target acquisition often requires aerial or ground insertion and the environment may not include a littoral. Sea control may not be important, while air control may be vital. As with hydrographic reconnaissance, the immediate effect of target acquisition is an improvement in U.S. intelligence. But the extended effect is the successful engagement with resulting damage, an issue that draws non-SOF fire support into the analysis. The ultimate effect concerns the degradation in overall enemy capability as a result of this damage. Thus, the illustrative tasks have extended and ultimate effects of very divergent nature.

Unconventional Warfare and Foreign Internal Defense Poorly Understood

Analysis of these missions requires political, economic, social, and cultural data that may be unavailable or controversial. Elementary data, such as the size and composition of irregular forces, may be in doubt; yet success may demand a thorough knowledge of the region in all of its aspects with emphasis on the conditions that nourish insurgency. The Afghan mujahideen, for example, were powerfully motivated by their conviction that the Kabul government was godless and unpleasing to Allah. Motivation of this sort is difficult for an outsider to appreciate, much less to measure precisely. Even if an opinion survey could precisely measure motivation, it might be impractical to conduct with an insurgency in progress. Poorly understood input variables of this sort make these missions, especially their success over time, extremely difficult to analyze.

4. SCOPE OF SURVEY

AGENCIES AND MODELS SURVEYED

The survey included elements in the Office of the Secretary of Defense (OSD), elements of the Joint Staff, analytic agencies supporting the Services, and military educational institutions including elements of Training and Doctrine Command (TRADOC) at Fort Leavenworth, Kansas.[1] These organizations were chosen for their connection to resource allocation decisions, the ultimate concern of this study. Figure 4.1 gives a schematic overview of agencies surveyed and models encountered during the survey.[2]

Office of the Secretary of Defense

OSD PA&E. Land Forces Division, General Purpose Programs, in the office of the Assistant Secretary of Defense (Program Analysis and Evaluation) (OASD PA&E), uses TACWAR to analyze theater-level conflict. General Research Corporation and Vector Research provide operators for the system. To date, analysis using TACWAR has focused on issues of closure and force structure in Southwest Asia using attrition and FLOT[3] trace as measures of merit. In the near future, Land Forces Division intends to develop a model for the Korean theater, and eventually one for the European theater. As a result of current policies,[4] the operators of TACWAR for Land Forces Division have little contact with the operators of TACWAR for J-8.

OSD NA. The Director of Net Assessment in the Office of the Secretary of Defense (OSD NA) sponsors and contracts with RAND for use of RAND Strategy Assessment System (RSAS). RSAS is a global simulation of strategic mobility and air-land-sea combat employing

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[1]RAND itself was not among the agencies surveyed, but the RAND Strategy Assessment System (RSAS) was covered because of sponsorship by OSD/NA and use by military educational institutions. Similarly, the Institute for Defense Analyses (IDA) was not surveyed, but TACWAR, a theater-level model developed by IDA, was covered because of sponsorship by J-8 and widespread use. Similarly, the survey did not include private companies involved in model development and defense analysis, but we visited BDM, Booz, Allen & Hamilton, Inc., CACI Products Company, Computer Sciences Corporation, and Science Applications International Corporation (SAIC) to obtain additional information on models under development.

[2]In the literature, model names are variously acronyms, abbreviations, and suggestive titles. We have employed the predominantly used form for each model.

[3]FLOT usually means the line of contact between opposing forces in the context of military modeling.

[4]JCS Memorandum of Policy (MOP) 39 establishes policy for release of documents originating in the Joint Staff. In practice, documents concerned with operational plans are not releasable.
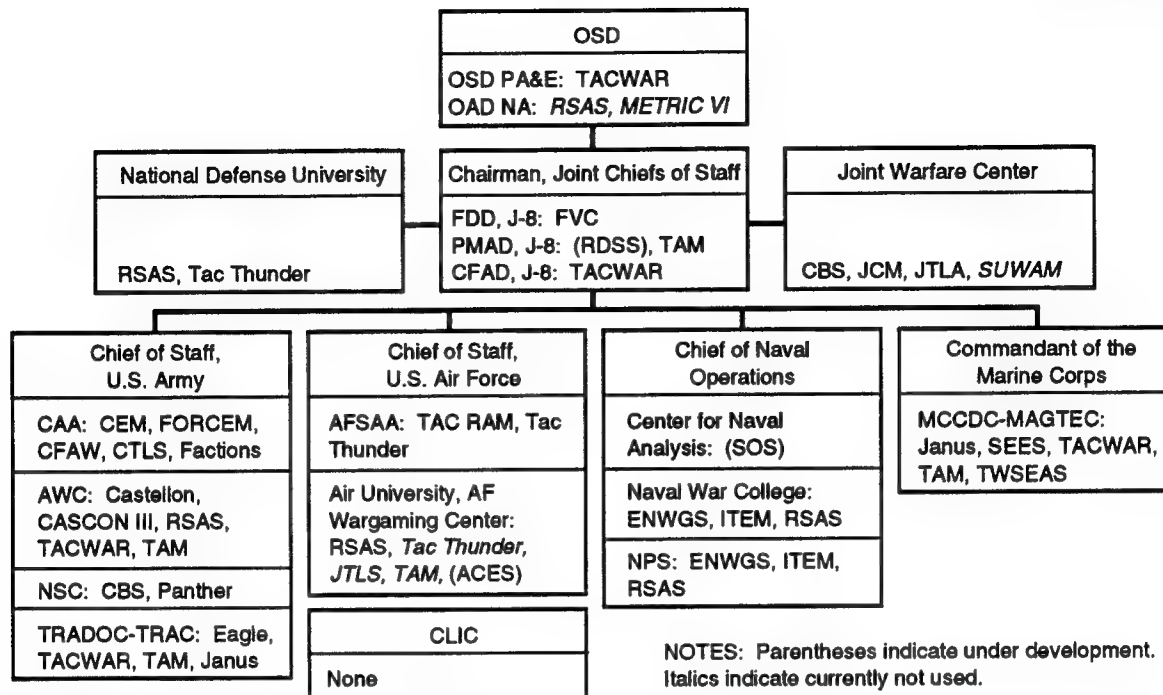
RAND#036-4.1-1092

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                            ┌─────────────────────────────────────┐
                            │                OSD                  │
                            ├─────────────────────────────────────┤
                            │ OSD PA&E:  TACWAR                    │
                            │ OAD NA:  RSAS, METRIC VI             │
                            └─────────────────────────────────────┘

┌───────────────────────────┐ ┌─────────────────────────────────┐ ┌───────────────────────────┐
│ National Defense University│ │ Chairman, Joint Chiefs of Staff │ │   Joint Warfare Center    │
├───────────────────────────┤ ├─────────────────────────────────┤ ├───────────────────────────┤
│                           │ │ FDD, J-8:  FVC                  │ │                           │
│                           │ │ PMAD, J-8:  (RDSS), TAM         │ │                           │
│ RSAS, Tac Thunder         │ │ CFAD, J-8:  TACWAR              │ │ CBS, JCM, JTLA, SUWAM     │
└───────────────────────────┘ └─────────────────────────────────┘ └───────────────────────────┘
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Chief of Staff, U.S. Army	Chief of Staff, U.S. Air Force	Chief of Naval Operations	Commandant of the Marine Corps
CAA: CEM, FORCEM, CFAW, CTLS, Factions	AFSAA: TAC RAM, Tac Thunder	Center for Naval Analysis: (SOS)	MCCDC-MAGTEC: Janus, SEES, TACWAR, TAM, TWSEAS
AWC: Castellon, CASCON III, RSAS, TACWAR, TAM	Air University, AF Wargaming Center: RSAS, *Tac Thunder, JTLS, TAM*, (ACES)	Naval War College: ENWGS, ITEM, RSAS	
NSC: CBS, Panther		NPS: ENWGS, ITEM, RSAS	
TRADOC-TRAC: Eagle, TACWAR, TAM, Janus	CLIC		
	None		

NOTES: Parentheses indicate under development. Italics indicate currently not used.

Figure 4.1—Agencies and Models Surveyed

nuclear and conventional forces, which has been in continuous development since 1980.[5] RSAS is driven by Analytic War Plans, which resemble real war plans and are written in an English-like programming language. RSAS has been used extensively by RAND to support war games and analysis of a wide variety of issues ranging from nuclear strategies to regional balances and the possible courses of theater-level conflict in Europe, Southwest Asia, and Korea.[6]

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[5]RSAS is designed as a largely self-documenting model. It includes on-line help and embedded documentation. Analytic War Plans and many adjudication routines are written in RAND-ABEL®, an English-like language intelligible to the non-programmer. In addition, RAND has produced a large amount of hard copy documentation available to authorized users of RSAS. This documentation includes guides to each new release version, e.g., RSAS 4.6 documented in January 1992, and the *RAND Strategy Assessment System (RSAS) Newsletter,* published quarterly and distributed to users. The *Newsletter* provides guidance on new features of the RSAS and summarizes analysis supported by the RSAS, including articles submitted by users. Publications available to non-users include: Bruce W. Bennett, et al., *RSAS 4.6 Summary,* RAND, N-3534-NA, 1992; Patrick D. Allen and Barry A. Wilson, *Secondary Land Theater Model,* RAND, N-2625-NA, July 1987; Norman Z. Shapiro, et al., *The RAND-ABEL® Programming Language: Reference Manual,* RAND, N-2367-1-NA, December 1988; Paul K. Davis, *An Analysts' Primer for the RAND-ABEL® Programming Language,* RAND, N-3042-NA, May 1990.

[6]Examples are the Joint Land, Aerospace, and Sea Simulation (JLASS) game conducted annually at the Air University, and the Global Wargame conducted annually at the Naval War College.

OSD NA also sponsors Metric VI, a theater-level simulation of air-land-sea combat under development by BDM. BDM is the sole user of Metric VI. This simulation is highly detailed and includes explicit representation of communications nodes and sensors. It includes a suite of supporting software, such as a graphics program based on FULCRUM, a product of the Defense Mapping Agency that employs laser disc technology. At the time of the survey, OSD NA had requested BDM to incorporate SOF into Metric VI and to analyze special operations, especially strike reconnaissance and direct action, in support of large-scale conventional warfare.[7]

Joint Staff

The survey encompassed models used by the Force Structure, Resource, and Assessment Directorate (J-8); and the Joint Warfare Center, subordinate to the Operational Plans and Interoperability Directorate (J-7).

CFAD, J-8. Conventional Forces Analysis Division (CFAD), J-8, uses TACWAR to analyze theater-level conflicts in Europe, Southwest Asia, and Korea. This analysis helps in assessment of force structure and mix required to accomplish theater objectives. J-8 exercises configuration control over a baseline version of TACWAR, which is available to all users. In addition, each user is free to develop a site-specific version to fit his individual needs. Potomac System Engineering provides operators for the J-8 installation. This corporation also supports TACWAR at Headquarters, Central Command (USCENTCOM). USCENTCOM has contributed substantially to the development of TACWAR, in particular to the logistic module. USCENTCOM prepared the most complete documentation currently available for TACWAR.[8]

TACWAR was originally developed by the Institute for Defense Analyses (IDA), which still retains its own version of the model. It is a piston-style attrition model that does not include maneuver warfare, such as amphibious assault, vertical envelopment, or flanking attacks.[9] Tactical aviation is played, but only in its effects on the ground war. Naval forces

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[7]Metric VI is Government owned, but there are no near-term plans to extend use beyond BDM. The model contains several hundred thousand lines of undocumented FORTRAN code. Startup would require BDM to document this code, to prepare training materials, and probably to assemble a team of instructors. Interview, John H. Milam, Vice President, Defense Planning and Programs, BDM, November 12, 1991. Because of lack of documentation, we were unable to obtain a detailed understanding of Metric VI during the survey.

[8]This documentation applies to USCENTCOM Version 3.2, which may vary from the baseline version and other site-specific versions. Since TACWAR is written in FORTRAN and on-line documentation is not provided, operators must rely on manuals to understand the adjudication processes. See TACWAR *Ground Analyst Guide*, TACWAR *Air Analyst Guide*, TACWAR *Logistics Analyst Guide, and TACWAR Data Dictionary Input*, USCENTCOM, August 1991.

[9]A skilled operator of TACWAR can simulate maneuver by manipulating the axes of advance, called "sectors." For example, combat performed sequentially by the same force on two overlapping

and strategic mobility are not played. Command and control is not modeled, nor is the effect of intelligence on the battlefield. The attrition calculations for ground combat are based on a sophisticated routine referred to as "Antipotential Potential" methodology, which optimizes weapons employment for sets of weapon-on-weapon allocations as affected by the tactical situation. TACWAR is deterministic and runs autonomously from large data files prepared at the outset of a game. It is not intended to be interactive, although an operator may stop the simulation periodically to examine the course of events. This type of simulation is designed for conventional forces fighting set-piece battles at the corps level across a broad front. TACWAR has no representation of SOF or special operations, except as scripted effects.

PMAD, J-8. Politico-Military Assessment Division (PMAD), J-8, sponsors and uses two models: Theater Analysis Model (TAM) and Regional Development Simulation System (RDSS). TAM was developed for the Joint Staff by Booz, Allen & Hamilton, Inc. It is designed to support rapid, first-cut assessment of theater-level operations and seminar-style wargaming. It is not intended to support highly detailed analysis. The original design included a Maritime Campaign Model, but to date only the AirLand Campaign Model and the Air Engagement models have been developed. TAM offers a relatively simple piston-style representation of ground combat with tactical aviation played as it affects the ground war. In contrast to TACWAR, TAM allows quick development of a theater representation and is highly interactive. It is stochastic with numerous random draws. However, an operator can replicate the results of previous games by selecting the same random number to seed the generator at the outset of a game. Booz, Allen & Hamilton, Inc., has prepared a User's Manual, which is supplemented by the analysis of parameters and algorithms prepared by the Canadian Department of National Defense.[10]

TAM has no representation of SOF or special operations. To represent a raid, for example, the operator scripts the placement of one unit in contact with another and gives the raider an arbitrary increase in effectiveness.[11] Other aspects of maneuver warfare can be represented by similar manipulations. The merit of TAM lies in its greater ease of setup and

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sectors might capture the effect of flanking attacks directed against that force. However, the basic design does not permit sectors to intersect.

[10]*Theater Analysis Model (TAM) Airland Campaign Model User's Manual*, Booz, Allen & Hamilton, Inc., October 4, 1990, describes step by step the construction of a theater and interactions during a game. However, it does not explain the adjudication process. For adjudication, see Christian Menard, *The Theatre Analysis Model (TAM), Version 3.10, Documentation of the Campaign Model*, Canadian Department of National Defense, Operational Research and Analysis Establishment, July 1991.

[11]*Theater Analysis Model (TAM) Airland Campaign Model User's Manual*, 1990, p. 6-6.

user friendliness in contrast with TACWAR. While months of highly skilled work are required to create a new TACWAR theater, a new TAM theater can be ready in weeks or even days. Further, TACWAR is so difficult that it generally requires contract employees as operators, while TAM can be run by military personnel after a few weeks of training. [12]

RDSS is a unique model of country-level stability as affected by allocation decisions in political, economic, and military spheres of activity. Its precursor was developed by Booz, Allen & Hamilton, Inc., under contract to the U.S. Government following the overthrow of the Shah of Iran. The model was intended to support analysis of developing countries for evidences of instability with a view toward predicting when major upheavals were likely to occur.[13] Booz, Allen & Hamilton, Inc., is currently in final development of RDSS with release planned for late 1992. In the interim, Booz, Allen & Hamilton, Inc., has conducted a series of demonstrations ("Island Reach") to perspective users under J-8 auspices. PMAD expects to use RDSS for regional assessments including analysis of low intensity conflict and foreign internal development.[14]

RDSS is a model with allocation decisions affecting the flows.[15] The decisions are those taken in the upper levels of government and bureaucracy, such as the expenditures budgeted for military and police forces. RDSS does not explicitly represent military units or military operations. It does, however, represent forces in terms of manpower, supplies, equipment, and training, and the allocation of these forces to missions, such as security or counternarcotics. It assesses a "mission coercive potential" for each mission based on the resources applied to it. It simulates combat between government and opposition forces and produces results in terms of casualties, equipment losses, and consumption of supplies. While none of these routines explicitly simulate SOF performing the UW or FID missions,

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[12]J-8 framed a project known as the Rapid Scenario Processor (RSP) which would make TACWAR more flexible and responsive by aggregating such variables as military geography and unit characteristics. However, the users have evinced little interest in this project to date. Interview, Art Parman, J-8 manager of TACWAR, January 8, 1992.

[13]Interview, Lawrence Hamby, Robert J. White, and Peter L. Batcheller, Booz, Allen & Hamilton, Inc., January 15, 1992.

[14]Briefing: "Regional Development Simulation System (RDSS)," Politico-Military Assessment Division, J-8, July 25, 1991.

[15]Booz, Allen & Hamilton, Inc., is in the process of completing documentation on RDSS. The partial documentation currently available includes *RDSS Runtime System User's Manual*, Version 2.1, Booz, Allen & Hamilton, Inc., December 1, 1991, and a standard briefing, undated. PMAD prepared the overview briefing referenced above. J-8 has engaged RAND to review RDSS for consistency and methodology, in effect to perform verification and validation. John Friel, RAND, is performing this work in close coordination with analysts at Booz, Allen & Hamilton, Inc. During our survey, John Friel, RAND, provided printouts of the model structure using iThink™ iconography and a listing of variables.

RDSS does simulate at the country level the environment in which SOF might expect to operate.

FDD, J-8. Force Design Division (FDD), J-8, receives assessments from CFAD supported by TACWAR. In addition, FDD has used a spreadsheet model called Force Value Calculator (FVC) to assess the "value" (actually the utility) of force mixes at various budget levels. Each force element—e.g., a carrier battle group—is rated according to expert military judgment for lethality, survivability, political acceptability, deterrent value, and deployability by region and environment. The environments are peacetime, conflict, and general war. The primary output is utility curves with strategic forces on the Y-axis and conventional forces on the X-axis contained within a budgetary line. The most useful force should appear at the tangent of a curve with the budgetary line.[16] The only SOF rated in FVC was a generic Special Forces (SF) group in the Army's force structure. The values for this force element were selected in consultation with officers acquainted with special operations, who tend to see SF as being very useful in a wide variety of regions and environments.[17] In view of the high level of aggregation inherent in FVC, it would be inappropriate to add other SOF such as SEALs or Ranger battalions.

PBAD, J-8. Program Budget and Analysis Division (PBAD), J-8 does not operate externally developed models or simulations. Each analyst is free to develop any spreadsheets he needs to support his work. The division receives analysis from CFAD and FDD which establishes that a given force structure is probably adequate within the scenarios examined, but does not address questions of force mix and cost effectiveness. In any event, it is doubtful that a model or simulation could fruitfully analyze a trade-off between SOF and elements of conventional force.[18]

JWC, J-7. At the time of the survey, J-7 was in the process of organizing a Simulations Division which would presumably oversee the activities of the Joint Warfare Center (JWC) at Hurlburt Field, Florida. JWC operates under the guidance of J-7 to support the Commanders-in-Chief (CINC) of unified commands. Each CINC develops his own schedule of exercises and war games and may select the support he finds most appropriate.

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[16]Interview, Lieutenant Colonel Roy Rice (USAF), Force Design Division, Force Structure and Resource, J-8, December 31, 1991. Force Value Calculator is undocumented and Rice was not at liberty to reveal the algorithms. In Rice's opinion, rationale generated to select input values was the most valuable part of the analysis.

[17]Ibid and interview, Colonel Robert Cowles (USA), Office of the Secretary of Defense, Special Operations/Low Intensity Conflict (OSD SO/LIC), January 22, 1992. Cowles was formerly Chief, FDD, and helped to rate SF groups for FVC.

[18]Interview, Colonel Walter C. Neitzke (USA), Chief, Program and Budget Analysis Division, Force Structure and Resource, J-8.

The U.S. European Command (USEUCOM) has its own dedicated support, the Warrior Preparation Center (WPC). WPC operates two large models, Ground War Simulation (GRWSIM) and Air War Simulation (AWSIM). Other CINCs lack a comparable organization and do not have sufficient resources within their own staffs to support elaborate simulations. In recent years, USCENTCOM, U.S. Atlantic Command (USLANTCOM), U.S. Pacific Command (USPACOM), and U.S. Southern Command (USSOUTHCOM) have requested exercise support from JWC.[19] To provide this support, JWC currently operates three models: Joint Theater Level Simulation (JTLS), Corps Battle Simulation (CBS), and Joint Conflict Model (JCM).

JTLS is sponsored by JWC as a component of the Modern Aids to Planning Program (MAPP), which provides computer-assisted decision aids to the unified commands. Like CBS, JTLS is derived from the earlier Joint Exercise Support System (JESS). JTLS is primarily intended to support exercises and military education. It may also assist analysis, but large requirements for manpower and slow run times, generally on the order of 4:1 (real time:game time), sharply limit iteration. Documentation is provided jointly by JWC and the Defense Information Systems Agency.[20] JTLS explicitly models ground, air, and naval units in the context of theater-level combat operations. Players maneuver units freely on a hexagonally defined playing surface overlaid on operational maps. Adjudication is stochastic using random number streams to vary results within expected limits. JTLS is designed to support a two-sided interactive command post exercise (CPX) with asymmetrical intelligence.

JTLS Version 1.8A includes a representation of SOF in the SR and DA missions.[21] Explicit SOF units can be created and covertly moved into hexagons containing opposing forces where they can engage the opposing force or remain in covert status. To accomplish insertion, a user may create explicit SOF-dedicated aircraft with special characteristics, such as an MC-130. Insertion can also be executed by submarine with stochastic trials against opposing sonar coverage. If operating covertly, SOF units receive a stochastically generated

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[19]Interview, Lieutenant Colonel Terry Peters (USAF), Joint Warfare Center, Hurlburt Field, Florida, May 24, 1992.

[20]The most recent JTLS documentation, dated March 1992 and describing JTLS Version 1.8A, includes these volumes: *JTLS Version [1.8A] Description Document, JTLS Information Management Terminal User Guide, JTLS Graphics User Guide, JTLS Scenario Development System User Guide, JTLS Scenario Preparation Program/Scenario Verification Program User Guide, JTLS Lanchester Coefficient Development Tool User Guide, JTLS Installation Manual, JTLS Technical Coordinator Guide, JTLS Data Requirements Manual, JTLS Controller Guide,* and *JTLS Player Guide,* published jointly by Joint Warfare Center, Hurlburt Field, Florida, and Defense Information Systems Agency, Washington, D.C. The *Analyst Guide,* which describes algorithms in the Combat Events Program, was unavailable during our survey because of a delay in publication. We used the *Analyst Guide for JTLS Version 1.7,* published in January 1991 supplemented by interviews at JWC.

[21]SOF enhancement to JTLS Version 1.7 was requested per MAPP Change Request (MCR), USSOCOM, January 3, 1991.

time to detection, which is reached at a preset detection rate. This rate will be higher if the opposing force is actively searching for the SOF unit, but units conducting active searches are penalized by slower movement rates. SOF and agents ("HUMINT teams") generate intelligence on forces and objects, such as airfields and bridges, within their areas of coverage and this intelligence can be used for targeting purposes.[22] If not operating covertly or subsequent to detection, SOF units behave like conventional units except that their combat power has a special multiplier. SOF units can also damage objects, such as bridges, and attack supply convoys.

Where appropriate, JWC operates CBS, another JESS derivative scheduled to receive an SOF enhancement. However, the primary user of CBS is the Army's National Simulations Center at Fort Leavenworth, which is discussed below.

JWC sponsors the Joint Conflict Model, a software suite intended to enhance the Janus Model developed by Lawrence Livermore National Laboratory. Janus is a tactical-level model of individual shooters, such as riflemen or aircraft, maneuvering and engaging within a realistic tactical environment that considers such factors as range and terrain masking. It is an event-driven model that uses probability of detection and probability of kill tables to adjudicate engagements. JCM is an enhancement intended to allow aggregation to the level of a joint taskforce that might include tactical air squadrons, amphibious assault groups, and brigades of ground forces. Like Janus, JCM permits considerable SOF play at the tactical level. A user can create SOF units and their special equipment in a menu-driven environment. SOF units can be inserted by air or sea to accomplish SR and DA missions. The extent of SOF play will depend on the scenario and CINC's interest reflected in the game design.[23]

In addition to these models, JWC retains, but does not currently use, Strategic Unconventional Warfare Assessment Model (SUWAM). The concept for SUWAM was developed at the National Defense University (NDU) in 1983 in response to the requirements generated by the Global War Game of the previous year. In 1987, JWC adopted SUWAM and sponsored a redesign that became Version 4.0. SUWAM is an exercise driver that produces plausible outcomes for SOF missions by random draw from a matrix. Each SOF mission is modeled as a series of events—e.g., air drop, infiltration, raid, escape and evasion. For each event, a random draw determines the row entry in the applicable outcome matrix. Selection

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[22]*JTLS Data Requirements Manual*, 1992, pp. A-112 to A-115; *JTLS Player Guide*, 1992, pp. A-190 to A-191; interview, Major Bernard Wistoff (USA), JWC, March 25, 1992.

[23]Major Pitt Merryman (USAF), *Joint Conflict Model (JCM), Version 1.0*, undated; interview, Major Merryman, March 25, 1992. At the time of this interview, JCM could not be demonstrated because of difficulty with file permissions.

of a column is affected by situational factors, such as threat level for an airdrop. Entries in a column reflect appropriate shifts—e.g., the column for a high threat level has relatively few entries reflecting favorable outcomes for insertion. It is not clear whether JWC still has a requirement for SUWAM, given the SOF enhancements to JTLS and CBS.[24]

Analytic Agencies

The survey included analytic agencies supporting Service staffs. Among these agencies were the U.S. Army Concepts Analysis Agency (CAA) in Bethesda, Maryland; the Air Force Studies and Analyses Agency (AFSAA), Pentagon; the Center for Naval Analyses (CNA), Alexandria, Virginia; and the Army-Air Force Center for Low Intensity Conflict (CLIC), Langley Air Force Base, Virginia.

Concepts Analysis Agency. CAA is a field operating agency subordinate to the Deputy Chief of Staff for Operations and Plans, the Army Staff. It is the Army's primary agency for modeling theater-level combat.[25] CAA uses Concepts Evaluation Model VI (CEM VI), Contingency Force Analysis Wargaming (CFAW), and Factions. It currently sponsors the development of two putative successors: Current Theater-Level Simulation (CTLS)[26] to replace CEM VI, and Next Generation Wargame (NXG)[27] to replace CFAW.[28] In addition, CAA retains but does not often use, Combat Base Assessment Model (CBAM) developed by BDM. CAA is considering adoption of Vector in Commander (VIC) as a possible replacement for CBAM.[29]

CAA is the sponsor and sole user of CEM. Every two years, CAA has conducted an OMNIBUS exercise using CEM in the context of a NATO-Pact war to assess capabilities of the Army's current force and to develop requirements for the Army's support structure. CAA also used CEM to analyze operations in Southwest Asia during Desert Shield and briefed the results to the Army Staff.[30] CEM is an autonomous, piston-style combat model whose

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[24]*SUWAM 4.0, Strategic Unconventional Warfare Assessment Model User's Manual*, JWC-TN-89-1, Joint Warfare Center, March 1989; interview, Major John McGarry (USA), JWC, March 25, 1992.

[25]In principle, CAA has responsibility for theater-level modeling, and TRADOC Analysis Command (TRAC) has responsibility for division-level and below. In practice, the responsibilities are less cleanly divided.

[26]Through 1991, Deputy Under Secretary of the Army (Operations Research) fully funded CTLS development. CAA controls development by programmers at Jet Propulsion Laboratory. If development proceeds according to plan, CTLS may be ready for release in 1993. Interview, John E. Shepherd, CTLS project leader, CAA, November 20, 1991.

[27]According to current plans, NXG will be available for beta testing in August 1992. Summit Research, Rockville, MD, is the developer. Interview, Robert Hart, CAA, April 12, 1992.

[28]CTLS and NXG are provisional names that may change.

[29]Interview, Wallace W. Chandler, Chief, Models Development Division, CAA, November 20, 1991.

[30]Interview, Ralph Johnson, CAA, November 20, 1991.

primary outputs are FLOT movement, attrition, and ammunition consumption. Attrition is calculated using the ATCAL[31] method, which uses killer-victim scoreboards and target priorities to calculate kill rates defined as the potential kill rate that can be eliminated from the opposing side.[32] CEM includes a representation of close air support, allocated in the same proportions as artillery battalions within a corps sector. CEM is designed to analyze protracted combat at corps level and division level across a broad front, such as Central Europe. It does not consider asymmetrical intelligence, maneuver, vertical envelopment, or amphibious operations. It does not represent SOF and/or any aspect of special operations. Current plans for further development of CEM concentrate on attrition issues, such as the recovery of abandoned vehicles, ammunition consumption for reasons other than engagement, and discrimination of crew casualties by a weapons system.

CAA has been the sole user of CFAW since 1983.[33] CFAW is a model designed to support wargaming, but it has analytic applications. It is validated by the professional judgment of military officers concerning the plausibility of its outcomes.[34] It is a two-sided game of air-land combat played on hexagons normally 5–8 kilometers on a side. Game time runs continually, normally at a ratio of about 8:1 so that players have enough time to react to events. The model is structured to accommodate up to 1,000 military units on each side, including artillery and logistic support units. Players give explicit orders to units, such as the order for artillery to fire from one hexagon onto another. Each side knows the exact locations of its own forces and the opposing forces in direct contact—i.e., in adjacent hexagons. In addition, each side receives intelligence derived from human intelligence and sensors. Human intelligence is generated by a command that causes nominal human agents to be sent to hexagonal areas where they report on enemy activity.[35] This command can be used to simulate SOF in the SR mission, but SOF is not explicitly represented.

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[31]*ATCAL: An Attrition Model Using Calibrated Parameters*, U.S. Army Concepts Analysis Agency, CAA-TP-83-3, August 1983; Concepts Evaluation Model VI (CEM VI), Volume I—Technical Description, U.S. Army Concepts Analysis Agency, January 1985, revised October 1987, pp. 5-7 to 5-20 and Appendix B.

[32]The ATCAL methodology is called "Antipotential Potential" in TACWAR. ATCAL and Antipotential Potential will produce similar results if there are no anomalies in extrapolation but they employ different procedures for convergence on a solution to simultaneous equations.

[33]CFAW is undocumented, except for comments embedded within the FORTRAN code. However, a rough description is contained within: "CFAW Player's Handbook," U.S. Army Concepts Analysis Agency, undated handout; Richard E. Darilek, *Gaming Nonreduction Measures (NoREDs) for Conventional Armed Forces in Europe (CFE)*, U.S. Army Concepts Analysis Agency, November 1990, pp. 12–17.

[34]Interview, Russell Pritchard, CAA, December 12, 1991.

[35]The order syntax is "INTEL AA11" where AA11 refers to a hexagonal area. The model does not play a specific team, nor adjudicate its detection. At six-hour intervals, the side issuing the order receives reports concerning opposing activity and strengths within the hexagon.

CAA uses Factions to support analysis of likely scenarios that could affect Army planning. It was previously used for analysis of the NATO region and will probably be used to support similar studies of the Pacific Rim, Southwest Asia, and Latin America. Factions is a simple model of interactions among political interest groups. It uses expected utility equations to determine the likely outcome for an issue that involves interest groups which vary according to positions on the issue, power to affect the outcome, and salience—i.e., degree of concern. Primary output is a point on a linear scale representing a forecasted outcome of an issue where the extremes represent complete resolutions and points between represent partial resolutions of the issue.[36] Factions does not represent SOF or special operations, although it might be used to analyze the environment in which SOF would be employed.

CAA operates the Conflict Analysis Center, which conducts political-military games to address issues too broad for systemic wargaming. Players are typically mid- to high-level officials, including general officers, with expert knowledge of the regions and issues to be addressed.[37] CAA supports these games with combat models, including CFAW and RAND Strategic Assessment System (RSAS). CAA maintains a working RSAS, but generally requires support from RAND personnel when RSAS is used to support a game. The political-military games, such as TAE KWON DO 90 and PII-SONG 90 conducted within a Korean context, include consideration of special operations. In addition, CAA has a continuing interest in low intensity conflict (LIC), as evinced by a workshop held in June 1991 that identified models applicable to LIC.[38]

Air Force Studies and Analyses Agency. AFSAA is a field operating agency that reports to the Air Force Director of Programs and Evaluation.[39] Its primary function is to assess the Program Objective Memorandum (POM) submission. AFSAA uses TAC Resource Allocation Model (TAC RAM) and Tac Thunder to analyze the capabilities of alternative force

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[36]For a partial description of the Factions model, see *NATO 2000*, Strategy and Plans Directorate, U.S. Army Concepts Analysis Agency, July 1990, Appendix C. For background on development of the model, see Bruce Bueno de Mesquita, *The War Trap*, Yale University Press, 1981, and Bruce Bueno de Mesquita et al., *Forecasting Political Events, The Future of Hong Kong*, Yale University Press, 1990.

[37]John Elliot, "Political-Military Wargaming," U.S. Army Concepts Analysis Agency, undated information sheet. Elliot is Chief, Conflict Analysis Center.

[38]*Report of Proceedings of the Low Intensity Conflict Analysis Workshop (LICAWS)*, U.S. Army Concepts Analysis Agency and Army-Air Force Center for Low Intensity Conflict, undated. The workshop, held June 6–7, 1991 at CAA, identified 14 models, including Janus, CBS, JTLS, Panther, SEES, and CFAW as of interest to low intensity conflict.

[39]AFSAA, headed by a full colonel, is the successor to Air Force Center for Studies and Analyses which was headed by a general officer. AFSAA is tied more closely to the Program Objective Memorandum cycle than was its predecessor.

structures.[40] AFSAA currently performs no analysis of SOF or special operations. From the perspective of the Air Staff, USSOCOM is responsible for operational analysis of SOF assets within the Air Force.[41]

TAC RAM is an apex model[42] developed within AFSAA, which is the sole user. It is not directly linked to other AF models, but it accepts their outputs as data, adjudication parameters, and the values for various input variables. TAC RAM delivers one primary measure of effectiveness: number of ground attack sorties (GASs). One GAS equates to one sortie flown in the close air support or interdiction mission over a valid target. This methodology proceeds from the assumption that all other missions, such as air supremacy, are flown in order to make ground attack possible. TAC RAM includes an intelligence simulation that fuses data from seven sensor classes against six target sets. Currently, there is no representation of SOF performing the SR mission.[43]

AFSAA uses Tac Thunder to analyze the capabilities of forces in the context of operations in specific theaters. AFSAA sponsors Tac Thunder but has delegated configuration control to CACI Products Company. AFSAA heads a users' group that convenes at least annually. Tac Thunder was designed as an analytic model incorporating Air Force and Army doctrine for force employment. Ground combat is simulated using the ATCAL methodology inherent to CEM, the Army's theater-level model. Like CEM, Tac Thunder is a pure piston-style model; combat occurs along the FLOT trace or flanks of a FLOT trace, never in the rear areas. At various times, users have proposed other methodologies, such as network representations, but no one has ever worked out algorithms to produce reasonable behavior for forces in a network.[44] The Air Staff provided the design for the air war in Tac Thunder. The model builds an Air Tasking Order (ATO) based on the apportionments and allocations specified by the user, matching available aircraft to 24

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[40]A more complete listing of models currently in use would include: Extended Air Defense Simulation (EADSIM), a regional air defense model; SABSEL, a model to calculate expected damage based on data contained in the Joint Munitions Effectiveness Manual; Theater Attack Model, a model that balances aircraft attrition with expected damage to targets; and TAC BRAWLER, a few-on-few air engagement model. However, these models are concerned solely with aviation issues and have little relevance to SOF.

[41]Interview, Colonel George H. Dash (AF), Chief, Regional Forces Division, AFSAA, December 10, 1991.

[42]An "apex" model stands at the top of a hierarchy of models and accepts their outputs either manually or electronically.

[43]TAC RAM is undocumented, but it is written in iThink, a high-level language that is icon-driven and intuitively clear to the non-programmer. The above discussion is based on the briefing "TAC RAM Resource Allocation Model," Air Force Studies and Analyses Agency, October 1, 1991; and interview, Major Gregory Burgess (USAF), AFSAA, December 11, 1991. Burgess wrote TAC RAM.

[44]Interview, Zaven C. der Boghossian, Manager, Military Simulation Department, CACI Products Company, January 9, 1992. Prior to his departure from CACI, der Boghossian was responsible for support of Tac Thunder.

specified missions. There is no naval play in Tac Thunder, but analysts can model (unsinkable) carriers as airfields. Although designed to run autonomously for analytic purposes, Tac Thunder can also be run interactively to support wargaming. Tac Thunder crudely approximates target detection by maintaining two sets of data for each target, real and perceived. The same algorithm is used across all targets to degrade real data into perceived data according to an initial variable set by the analyst. There is no simulation of SOF performing the SR mission or any other special operations.

Center for Naval Analyses. CNA is a federally funded research and development center (FFRDC) responsive to the needs of the Chief of Naval Operations. CNA is currently developing Sequence of Strikes (SOS), a model of potential interest to SOF. CNA is the developer and sole user of SOS, which may be ready for release in 1992. SOS is an event-driven expected value model of carrier-based aviation in the ground attack role. It does not explicitly model intelligence or target acquisition. It has generally been used to analyze specific weapons systems.[45]

Prior to Goldwater-Nichols, SEALs were such a small item in the Navy's budget that they went almost unnoticed. Afterward, when SEALs were subordinated to USSOCOM, they became more visible and received attention from CNA. In particular, CNA published analyses linking training costs to SEAL capabilities and examining the signatures of submersibles and small craft. However, CNA currently has no projects in the SOF area.[46]

Army-Air Force Center for Low Intensity Conflict. CLIC reports to the Deputy Chief of Staff for Operations and Plans, the Army Staff, and the Deputy Chief of Staff Plans and Operations, the Air Staff. It was established in 1986 to serve as the Army-Air Force focal point for matters relating to military operations in low intensity conflict, including strategy, concepts, doctrine, and plans. CLIC currently uses no automated decision aids and has no near-term plans to acquire such aids. Two special operations qualified officers are currently assigned to CLIC. They are conducting an assessment of drug traffic in the Caribbean area under USLANTCOM auspices. Lack of reliable data and uncertainty concerning relationships prevent the use of models to support this assessment.[47]

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[45]Interview, Dennis P. Shae, Director, Warfare Modeling Program, Center for Naval Analyses, November 25, 1991. SOS is scheduled for completion and possible release in 1992. An earlier version of SOS was used internally and documented, but CNA was not at liberty to release this documentation to RAND.

[46]Interview, Robert S. Bell, Center for Naval Analyses, December 6, 1992.

[47]Interview, Major Richard Whitney (USA) and Major William Sanderson (USAF), Contingency Operations Division, Army-Air Force Center for Low Intensity Conflict, March 9, 1992.

Military Educational Institutions

The survey included the Army War College, Carlisle, Pennsylvania; the Air University, Maxwell Air Force Base, Alabama; the Naval War College, Newport, Rhode Island; and the Marine Corps Combat Development Command, Quantico, Virginia.

U.S. Army War College. The Center for Strategic Wargaming, U.S. Army War College (USAWC) uses Castellon, Computer-Aided System for Analysis of Local Conflicts (CASCON III), RSAS, TACWAR, and TAM. Castellon [48] is an analytic model of political and economic decisionmaking at the presidential level based in a fictitious Latin American country named "Castellon." Among the issues represented are requests to the United States for military equipment and military advisors in counterinsurgency. The center supported an advanced course with Castellon on an experimental basis, but found that the model had too little relevance to military affairs. The center then presented CASCON III[49] to students on an experimental basis and found it more useful than Castellon. CASCON III is a comparative data base containing snapshots of 66 post-WWII conflicts. The data consists of judgments on 540 factors made by three experts at the Center for International Studies of the Massachusetts Institute of Technology. A user can compare cases by requesting line graphs and other displays. While CASCON III can illuminate the background of conflict, it has little direct relevance to the military aspects of LIC.

The Center for Strategic Wargaming uses RSAS to support the core curriculum, advanced courses, and the Advanced Warfighting Studies Program. The core curriculum includes Course 4—Implementing National Military Strategy, which requires the students to translate strategic guidance into a campaign plan. Advanced courses focus on theater-level operations in selected regions. The Advanced Warfighting Studies Program involves case studies with up to four major campaign variants. Special operations are represented by scripted inputs during these games, if they are represented at all. In addition, the center uses RSAS to support JLASS.

The center has recently acquired TACWAR and TAM. It used TAM for the first time in January 1992 to support Course 4. Since all 18 seminars participate simultaneously, this application required 18 experienced operators, each working interactively. Special

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[48]University of North Carolina, Chapel Hill, developed CASTELLON and distributed it through Harcourt Brace Jovanovich, Inc. USAWC has documentation that offers only a broad overview of the model.

[49]CASCON was originally developed at the Massachusetts Institute of Technology (MIT) under sponsorship of the U.S. Arms Control and Disarmament Agency. CASCON III was developed by Prof. Lincoln P. Bloomfield, MIT.

operations were not played during these games.[50] The center has not yet used TACWAR, but anticipates use in support of the USAWC curriculum and perhaps in support of analytic studies for other agencies within the Army. The center acquired TACWAR in preference to CEM because TACWAR better represents joint operations.[51]

The Army War College offers two advanced courses that concern SOF: Course 311cj, SOF Operations, and Course 312j, Operational Challenges of Low Intensity Conflict. At present, neither course is supported by models.[52]

Air University. The Air Force Wargaming Center (AFWC) of the Air University (AU) provides support to computer-assisted war games and exercises. This facility supports as many as 39 games and exercises annually, involving over 10,000 players during the year. The schools within Air University supported by the Air Force Wargaming Center include the Air Command and Staff College (ACSC), the Air War College, Squadron Officer School, Combat Employment Institute, the School of Advanced Aerospace Studies, and the Center for Professional Development.

AFWC has several externally developed models, including Janus, JTLS, NWARS, RSAS, TACWAR, and TAM, but with the exception of RSAS, currently uses only internally supported models for main game support.[53] RSAS is used to support the Joint Land, Aerospace, Sea Simulation (JLASS) co-sponsored by the six senior service colleges and hosted at AFWC. The RSAS is run with RAND assistance during JLASS, but it is not otherwise used by AFWC. JLASS 92 had some SOF play, which was adjudicated by a separate SOF adjudication cell or by controller discussion and scripted, when possible, into the RSAS. The players were not allowed to differentiate between RSAS output and output from the SOF adjudication cell.

AFWC has developed many internal models, most on the tactical level. A model of potential interest to SOF is the Air Force Command Exercise System (ACES). ACES is a theater-level game currently under development and due to be completed in 1992. The strategic portion of the model has been used to support the STRATWAR game, an annual

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[50]Interview, Lee Fischbach, Center for Strategic Wargaming, USAWC, March 28, 1992. Fischbach is a member of the team that operates TAM and TACWAR.

[51]Interviews, Lee Fischbach and Dennis Konkel, Modeling Group B, Center for Strategic Wargaming, Army War College, March 28, 1992. Currently, the Strategic Studies Institute, USAWC, responds directly to the Deputy Chief of Staff for Operations and Plans, Army Staff, while the Center for Strategic Wargaming largely supports the college curriculum. However, the latter relationship may change after 1994 when the Center for Strategic Wargaming occupies a new facility and expands in size.

[52]Interview, James E. Trinnaman, Center for Strategic Warfare, Army War College, March 28, 1992. Trinnaman currently teaches Course 312j.

[53]TAM and TACWAR were used to shadow RSAS at JLASS 92. Future use of these models is undetermined.

ACSC two-sided global nuclear warfare game. The theater portion of ACES will be a hexagon-based game used to support various AU games, including one for the Air Command and Staff College, and others for the Royal Air Force and the Canadian Command and Staff College. All the data bases used are unclassified, and the allied games are played with a generic scenario to avoid political sensitivities. Each of the games will involve about 500 players.

The ACES design includes SOF units and the capability to perform SR and DA missions. The input of strategic targets is currently the Air Force Wargaming Center's highest priority. However, SR and DA will eventually be programmed, in response to increased interest in these issues and pressure from the intelligence and SOF communities.[54] Unlike many games and exercises in which the controllers can encourage SOF play by feeding information to the players off-line, an ACES-supported game is played directly on the terminal. Thus, there is no opportunity to input off-line analysis.

Naval War College. The War Gaming Department provides simulation and gaming support to the seminars, games, and exercises hosted by the the Naval War College. The War Gaming Department currently uses the Enhanced Naval War Gaming System (ENWGS) and RSAS to support these efforts. In addition, the War Gaming Department has numerous tactical models, which are exclusively naval.

ENWGS is the primary Naval War College gaming system, and it is the Navy's only approved computer-assisted gaming system. ENWGS was released in 1986. Although ENWGS originally supported over 80 percent of the Naval War College games and exercises, it is currently used only for about eight games/exercises a year, because of the recent shift to more gaming at the strategic level.[55] ENWGS-supported games include Sea Control (SEACON); games for the Naval Staff College and Naval Command College (NCC), which are both departments of the Naval War College; a game for the National Security Industrial Association (NSIA); a Northwest Pacific (NWPAC) game; and a game for the French navy. SEACON is run for the various Navy laboratories, testing futuristic systems in a future scenario. The Naval Staff College game is held for junior foreign students of the Naval War College and is based on a fictitious third-world scenario. The NCC game is also held for War College students. The NSIA game is attended by 100 to 150 senior executives of defense contracting companies and is intended to be an introduction to naval operations. The NWPAC exercise is a joint and combined effort, involving U.S. and Japanese air force and

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[54]Phone Interview, Major Dale Shoupe, Air Force Wargaming Center, 11 June 1992.

[55]Memo to Commander David Hutson, from Lieutenant Commander Gary J. Roberts, Wargaming Department, Naval War College, re: ENWGS objectives/utility, 22 January 1992.

naval participants, and U.S. Marine officers. It explores issues common to U.S. and Japanese forces. In addition, the War Gaming Department provided some Middle East gaming and analysis support to USCENTCOM prior to and following Operation Desert Storm.

All ENWGS-supported exercises are run continuously, with players watching the graphics display and providing orders to the operators at the keyboards. The level of information provided on the screen varies with the side played and the intelligence requested by the players. Although ENWGS includes a new amphibious module, beach reconnaissance is assumed or scripted. Players implement a landing plan and the craft deploy to the beach on a timeline, with no attrition to the landing forces during entry. There is no terrain detail, and once arrived, the amphibious forces are generally out of play. Carrier air is played, but any attrition to un-played ground forces is dependent upon the controllers. There have been some discussions about SOF additions to the model, but the funding immediately available will be used in 1993 to rehost the system to Ada and UNIX from the currently used PL1 and Multix.

ENWGS is manpower-intensive. There are currently more than 60 personnel that contribute to ENWGS games at the Naval War College, and a new game can take four to six months to design and implement. However, the Naval War College is a host site for ENWGS and can provide game support for remote ENWGS sites that require only 15 to 20 personnel.

The War Gaming Department has RSAS but does not actively use the system, with the exception of the annual Global War Game (GWG), which lasts three weeks and employs over 1,000 players. During GWG, RAND and other users of RSAS provide operators to run the system, which provides operational assessments of global and regional scenarios as requested by player cells.

The Center for Naval Warfare Studies (CNWS) at the Naval War College also has ITEM but does not currently use this system. The center plans to use ITEM to support seminars and individual study projects as required.[56]

Marine Corps Combat Development Command. The Wargaming Center, Marine Corps Combat Development Command (MCCDC), provides simulation support to the Marine War College, the Command and Staff College, the Non-Commissioned Officers' Academy, and the Amphibious Warfare School, including seminars or CPX at the level of a Marine Expeditionary Force (MEF). To provide this support, the Wargaming Center operates a variety of combat models including Security Exercise Evaluation Simulator (SEES), Janus,

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[56]Telephone interviews, Commander John Kennedy, Center for Naval Warfare Studies, 27 January 1992; 9 June 1992.

Tactical Warfare Simulation, Evaluation, and Analysis System (TWSEAS), JTLS, and TACWAR. The center plans to acquire Urban Combat Computer Assisted Training System (UCCATS).

The Wargaming Center uses SEES to support seminars and exercises at the Non-Commissioned Officers' Academy and the Amphibious Warfare School.[57] SEES is a shooter-level combat model developed by Lawrence Livermore National Laboratory to evaluate the security of nuclear installations against terrorist attack. SEES allows a user to build terrain, installations, weapons, and weapons platforms using menus and icons. A skilled user can build a fairly complex installation in a few days. As an example, the Wargaming Center currently supports a seminar that involves a simulated terrorist attack on the heliport at Quantico that serves Squadron One, the presidential unit. Six players participate simultaneously in the seminar, each at his own terminal, playing a different role in the scenario. These seminar games address some aspects of the CT mission on a purely tactical level.

The Wargaming Center uses Janus,[58] another product of Lawrence Livermore National Laboratory, to support war games. Janus is a shooter-level combat model that uses menus to interface with the user, very much like SEES. Janus is event-driven and produces game files that describe all events in sequence. Currently, the Wargaming Center uses Janus to support a seminar war game in the Advanced Course at the Non-Commissioned Officers' Academy. In this game, the students lead a raid by a Marine Expeditionary Unit-Special Operations Capable (MEU-SOC) on Pohang, Korea. The center also uses Janus to support a seminar game for students at the Marine War College. The current version of this game involves a five-battalion amphibious assault on an objective in Kuwait. Recently, the Wargaming Center used Janus to model an amphibious assault during Ulchi Focus Lens, a CPX/FTX (command post exercise/field training exercise) conducted by U.S. Forces, Korea.

The Wargaming Center uses TWSEAS to support seminars at the Amphibious Warfare School on the level of Marine Expeditionary Brigade (MEB) and at the Command and Staff College on the level of an MEF. TWSEAS has been in use and under development

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[57]In the near future, the Wargaming Center, Marine Corps Combat Development Command, expects to replace SEES with UCCATS, a further development of SEES that offers a three-dimensional view of urban combat.

[58]We are aware of three versions of Janus: Janus-L offered by Lawrence Livermore National Laboratory, the original developer; Janus-A developed for the U.S. Army; and JCM under development for the Joint Warfare Center. MCCDC uses Janus-L and Janus-A. The latter model has an improved representation of engineering obstacles.

since 1977, when it was first fielded at Camp LeJeune and Camp Pendleton.[59] TWSEAS is an interactive exercise-driver that requires large numbers of operators. As examples, a recent MEB CPX required about 80 persons directly involved with the terminals in some fashion, while an MEF CPX might require 150 or more. To ensure realism, players are not permitted direct contact with the terminals. TWSEAS represents terrain only as elevation, cover, and trafficability. It cannot adequately reflect the characteristics of landing areas and it does not contain an explicit representation of SEAL teams. During a game, players submit their requirement for reconnaissance of landing areas and the controllers generate realistic responses off-line. TWSEAS does include reconnaissance teams, typically four men on foot, although they can move by other means. These teams have been made undetectable because the detection algorithm was finding them too often.[60] These teams can call for air strikes and, thus, could represent SOF performing the SR mission.

The Wargaming Center also uses TACWAR and JTLS. It used TACWAR to support examination of employment options for an MEF during Operation Desert Storm. The center uses JTLS to support the course "MEF in the Defense" at the Command and Staff College. It had earlier used TWSEAS for this course but found TWSEAS inadequate because it did not simulate a complete theater. The center anticipates using JTLS to support ACE-92, an exercise to be conducted at the Warrior Preparation Center. In addition, the center has acquired Theater Assessment Model but has not used it to date.[61]

TRADOC at Leavenworth

The U.S. Army Training and Doctrine Command (TRADOC) maintains the National Simulations Center (NSC), subordinate to the Combined Arms Command (CAC), and the TRADOC Analysis Command (TRAC) at Fort Leavenworth, Kansas. Each of these activities operates its own set of combat models.

National Simulations Center. NSC uses Corps Battle Simulation to support the Battle Command Training Program (BCTP), also called "Warfighter." U.S. Army Program Manager, Training Devices (PM Trade) in Orlando, Florida, exercises configuration control

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[59]*Tactical Warfare Simulation, Evaluation, & Analysis System Employment, Manual,* Naval Ocean Systems Center, AN/TSQ-T9(V), June 1987, p. 1-1. See also *Tactical Warfare Simulation, Evaluation, & Analysis System, User's Overview,* Naval Ocean Systems Center, AN/TSQ-T9(V), November 1986.

[60]This flaw and others will likely be corrected in the next release. Science Exploration Incorporated, San Diego, is currently under contract to Naval Ocean Systems Command to rewrite TWSEAS in Ada with a C code-based graphics program. Interview, Lieutenant Colonel Paul Roy (USMC) and Major Richard Morell (USMC), Wargaming Center, MCCDC, February 21, 1992.

[61]Interview, Daniel Purcell and Jeffery Tkacheff, analysts and model operators, Wargaming Center, MCCDC, February 21, 1992.

over CBS.[62] Jet Propulsion Laboratory, California Institute of Technology, develops CBS under direction of PM Trade and review by NSC and other users, such as JWC. BCTP is a CPX normally conducted at each corps headquarters in an 18–24 month cycle—i.e., during each corps commander's tour of duty. During these CPX, each corps supports its own play, usually down to the level of brigade headquarters, while NSC provides mainframe support and plays the opposing force (OPFOR). Despite automation, corps-level CPXs require large amounts of manpower, on the order of 600 controllers and other support personnel, many of whom are drawn from the units being trained. CBS plays ground forces and air forces in direct support. It does not include strategic mobility, naval operations, or nuclear weapons effects. Ground forces maneuver on a playing surface of hexagons whose centers are three kilometers apart. Adjudication of ground combat may be deterministic, using a Lanchester-type model, or stochastic, using killer-victim equations and the results of a random draw. To increase realism, the user may impose a rule-based expert system called Combat Outcome Based on Rules for Attrition (COBRA).[63] Asymmetrical intelligence normally accompanies play.[64]

SOF are represented in CBS through expedients or "work arounds." SOF are "magic moved"[65] to appropriate locations to simulate their insertion. They are typically placed in an "avoid combat" mode that allows them to be within combat range of an enemy unit without combat occurring. They are detected when an enemy unit enters the same hexagon or when the probability of detection, as computed by a detection algorithm, exceeds a random number drawn from a uniform distribution.[66] As another possibility, SOF may initiate combat by receiving a "ground attack" order. However, SOF are small infantry units with extremely limited combat power. If they are to kill appreciable enemy forces, this effect must be

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[62]U.S. Army Program Manager, Training Devices, publishes comprehensive CBS documentation prepared by Jet Propulsion Laboratory. Current documentation appears in the series *Analysis and Training Systems Project, Corps Battle Simulation (CBS), Version 1.3.5*, Jet Propulsion Laboratory, 1991, available through PM Trade. At the time CBS was adapted from the Joint Exercise Support System (JESS), The Combined Arms Training Activity (CATA), Fort Leavenworth, published an overview: *Corps Battle Simulation, How to Train with CBS*, RDA Logicon, Tacoma, WA, December 1988.

[63]See *COBRA User's Guide, Corps Battle Simulation (CBS) Version 1.3.5*, Jet Propulsion Laboratory, Pasadena, CA, September 1991.

[64]"Ground truth" data from CBS is processed and transmitted to players through the Tactical Simulator (TACSIM). See *JESS/CBS-TACSIM Interface Description, Joint Exercise Support System (JESS)/Corps Battle Simulation (CBS)*, Jet Propulsion Laboratory, Pasadena, CA, April 1990.

[65]MAGIC MOVE is the syntax of a CBS order that allows an instantaneous move from one hexagon to another. "MAGIC" denotes an arbitrary input from the operator.

[66]*Analyst's Guide, Volume 1, Ground, Corps Battle Simulation (CBS)*, Jet Propulsion Laboratory, Pasadena, CA, May 1991, pp. 4-34 to 4-37.

scripted by the controllers.[67] SOF in the SR mission also fall outside the model and must be scripted if they are important to a game.

SOF enhancement to CBS is planned for Version 1.4, scheduled for release in December 1992. This enhancement will provide explicit SOF units with distinctive icons. They will be capable of insertion by air drop or helicopter, as well as through infiltration. They will be able to conduct strike reconnaissance against targets in the enemy rear area, such as ballistic missile launchers. With COBRA on, SOF will have special modifiers to increase their effectiveness and decrease their vulnerability in combat. With COBRA off, these distinctions will have to be reflected in the data base. SOF will also be able to conduct DA against targets such as SCUD launchers.[68]

Through the WARSIM-2000 project, NSC is developing a conceptual successor to the current Family of Simulations (FAMSIM), which includes CBS, Battalion Battle Simulation (BBS), Panther, and Janus. The central issue is whether the Army should continue to develop the FAMSIM models or attempt a completely new start. The Training Mission Area General Officers Steering Committee is charged with making this decision. According to current thinking at NSC, WARSIM-2000 would have open architecture,[69] keep staff at their normal work stations during a CPX, include electronic links to the existing decision support systems, and simulate joint and combined operations at the corps level.[70]

NSC sponsors and supports the use of Panther, a hybrid game that combines board play with computer-generated adjudications to simulate a counterinsurgency environment. There are currently two versions of Panther: Tier I and Tier II. Tier I is regularly used to support the *Fuerzas Unidas* (United Forces) series of exercises sponsored by USCENTCOM. To date, there have been 16 exercises in this series, all held in South American countries using indigenous personnel with no play of U.S. forces. Normally, the host country provides the keyboard operators and NSC has prepared a Spanish language version of Panther Tier I

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[67]Interview, Captain Howard Lee (USA), Division through Echelons Above Corps Division (DEAC Division), National Simulations Center, February 3, 1992.

[68]Memorandum, CBS 1.4 Modeling Workshop, Jet Propulsion Laboratory, May 8, 1991, and Interview, Lee. At the time of the interview, Lee was serving as NSC point of contact for SOF enhancement. His description of the enhancement exceeded the parameters envisioned in the referenced memorandum.

[69]Because the Jet Propulsion Laboratory based JESS on VAX computers, the JESS derivatives CBS and JTLS remain tied to VAX. "Open architecture" implies that the Army could support WARSIM-2000 with hardware from a wide spectrum of vendors.

[70]Interview, Herbert Westmoreland, Project Manager, WARSIM-2000, National Simulations Center, February 3, 1992.

to assist them.[71] NSC normally supports an exercise in this series with a two-man team. Tier II expands the simulation by modeling the geography of an entire country, and it is less robust than Tier I. NSC does not support the use of Tier II outside Leavenworth, but Command and General Staff College uses Tier II in the elective course concerning Foreign Internal Defense/Internal Defense and Development (FID/IDAD).[72]

Prior to a game, Panther controllers prepare a sequence of insurgent activities on a map overlay. Activities include the movements of guerrilla bands and events, such as the destruction of a power line or bridge. Government players become aware of insurgent activities through intelligence summaries issued by the controllers. They plan a counterinsurgency campaign, including the movements of their own patrols into areas where guerrillas are active. They monitor the locations of their forces by using cardboard counters on the map overlay. When government patrols encounter insurgents, combat ensues, which is adjudicated in considerable detail by the model. The simulation includes aircraft in the ground attack role and antiaircraft weapons. The primary measure of effectiveness is popular support within provinces of "Delmonico," a fictitious country that strongly resembles El Salvador. For example, the government may lose support if it engages insurgents in an urban area and inflicts civilian casualties. Logistic stocks appear during the simulation but are not actually played—i.e., there is no consumption. Panther games include PSYOPS prepared manually by the players. These are graded by the PSYOPS controller, who inputs the grade to the simulation. Panther also includes civil affairs operations, which are handled as scripted events synchronized with the board play. The civil affairs controller evaluates the success of missions and provides the players with intelligence when civil affairs are conducted successfully.[73]

TRADOC Analysis Command. The Scenario Wargaming Center (SWC), TRAC, uses TAM and sometimes Janus to initiate development of planning scenarios for TRADOC approval. Once approved, these scenarios support training, assessment of force structure,

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[71]The Spanish language version should have involved translation of just "boiler plate," such as headings, prompts, and on-line helps, but somehow developed defects that prevented a demonstration during our visit.

[72]Interview, Major Richard Koone (USA), Brigade and Below Division, National Simulations Center, February 4, 1992. Koone is the project officer responsible for Panther. His responsibilities include oversight of the Titan Corporation programmer under contract to NSC, who is currently re-writing Panther in PASCAL. This Panther follow-on is called Computer Assisted Staff Exercise Simulation (CASES), a name which seems unlikely to survive.

[73]PANTHER Tier I is documented in: *User's Guide, Basic Rules and Supplements Manual* (Book I), *How to Train Manual* (Book II), *Organizer's Manual* (Book III), and *Computer Operations Manual* (Book IV), Combined Arms Command—Training, Fort Leavenworth, Kansas, 1991. These manuals explain precisely how to organize and conduct a game but do not explain the adjudication algorithms.

and cost and operational effectiveness analysis (COEA) throughout the Army. To begin a scenario, SWC acquires threat data from the Threats Directorate, Combined Arms Center, and discusses operational concepts with appropriate commands, such as USPACOM for a Korean scenario. SWC consults with experts at Fort Bragg and USSOCOM regarding special operations. SWC may use Janus to examine crucial elements of particular battles. It uses TAM to analyze alternative courses of action (COA) on a theater level. This analysis is accomplished through interactive war games played by mid-level officers. The operators keep handwritten notes of players' decisions and the corresponding inputs to the models. If the outputs appear unrealistic, the operators review model parameters and make necessary changes. A series of games provides the basis for a scenario with excursions.

In some scenarios, special operations play an important role. For example, in developing a Korea scenario ("PACOM-1"), SWC is emphasizing North Korean SOF in the DA mission and U.S. SOF in the SR mission. SWC models North Korean SOF in TAM as a "munition" expended against high value targets.[74] SWC does not attempt to model U.S. SOF in TAM, but their actions are depicted in the scenario.

Production Analysis Directorate, Operations Analysis Center, TRAC, further develops a scenario through use of TACWAR. To date, Production Analysis Directorate has used TACWAR to analyze theater-level conflict in Central Europe and Southwest Asia. After SWC has completed its work, Production Analysis Directorate will begin work on a scenario for Korea. To reflect the effects of North Korean SOF, the Directorate will probably create a ballistic missile with a name like "NKor-SOF," which can be employed against U.S. air bases in Korea.[75]

Model Directorate, Operations Analysis Center, TRAC, is currently developing a new model of division- and corps-level combat called Eagle. TRAC has configuration control and accomplishes most development internally. However, Los Alamos Laboratory contributes research and Mitre Corporation is working on a module called the Adversarial Planner. Eagle is now close to completion, although it still requires further development in the area of fixed-wing aviation. It emphasizes command and control aspects of operations, and accepts order strings that use current Army terminology. Eagle uses the same attrition algorithms as VIC and is extremely data intensive. Although originally designed as an exercise driver,

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[74]Interview with Captain Oren Hunsaker (USA), Scenario Wargaming Center, TRADOC Analysis Command, February 5, 1992.

[75]Interview, Lieutenant Colonel Kenneth R. Close (USA), Senior Military Analyst, Production Analysis Directorate, Operations Analysis Center, TRADOC Analysis Command, February 5, 1992. Close heads a three-man team operating TACWAR. The Directorate is now forming a second TACWAR team to assist in scenario development.

Eagle may prove more useful in analysis. Eagle has no representation of strategic deployment, no naval play, no intelligence play, and no representation of SOF. There are no plans to include Eagle in WARSIM-2000. Over the near term, USCENTCOM will receive a beta version of Eagle for testing. Also, Eagle will be linked to the Simulation Network (SIMNET) for a proof of concept exercise in which Eagle will simulate artillery effects on M1 and M2 vehicles joined through SIMNET.[76]

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[76]Interview, Annette Ratzenburger, Program Manager, Model Directorate, Operations Analysis Center, TRAC, February 5, 1992. At the time of our visit, Eagle was undocumented and could not be demonstrated because the Model Directorate was undergoing renovation. However, the Model Directorate provided a video presentation of Eagle's chief features.

5. CANDIDATE DECISION AIDS

SELECTION CRITERIA

In the course of the survey, we encountered the 30 significant decision aids listed in Appendix C.[1] Not all of these were of sufficient importance to merit an assessment of adequacy for SOF analysis. To select candidates for assessment, we devised the following set of broad selection criteria:

- Currently supports analysis of alternative force structures
- Simulates theater- (taskforce-, corps-) level combat and
  - Is currently in use by one or more agencies, including the Joint Staff, Service-related analytic/wargaming agencies, and war colleges and universities
  - Or may be adopted
- Explicitly simulates one or more SOF missions.

The first criterion captures all decision aids that support analysis contributing to the Planning, Programming, and Budgeting System (PPBS). It includes Force Value Calculator, which is used to analyze the base force, although this model does not simulate combat. It also captures TAC Resource Allocation Model, which is used to support analysis of the Air Force POM, although this model is exclusively concerned with air operations. Explicit simulation of SOF or even relevance to SOF missions is not a requirement for selection.

The second criterion captures all decision aids that simulate combat at the theater level, joint taskforce level, or the level of an Army corps and that are currently in use or may be adopted by the agencies included in our survey. This criterion follows from the insight described in Section 3—i.e., analysis of SOF missions requires consideration of extended and ultimate effects that are felt at the operational levels of war. From the U.S. Army perspective, the lowest operational level is the corps, which integrates deep fires and accomplishes major campaign objectives. From joint perspective, a taskforce functions analogously to a theater command and may accomplish a small campaign, such as the

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[1]With few exceptions, the authors did not operate the decision aids encountered during the survey. To operate complex models such as CBS, RSAS, or TACWAR skillfully requires months of training. Our knowledge of the models presented in this section is based on demonstrations, interviews, and study of the available documentation. Extensive documentation is available for most of the mature theater-level models and forms the primary basis for our judgments.

intervention in Grenada. As the likelihood of general war declines, military planning will focus on major regional contingencies, increasing the importance of corresponding models. Eagle, which is evolving into a corps-level model, and JCM, which is intended to simulate joint taskforces, fall under this second criterion. Of course, all theater-level models, including ACES, CBS, CEM, CFAW, ITEM, RSAS, Tac Thunder, TACWAR, and TAM, are also captured by this second criterion. We included war colleges and universities as admissible users for two reasons. First, a model currently used for academic purposes may eventually be used for analysis. Second, the educational institutions may expand their analytic roles. For example, the Army War College plans to enlarge the Center for Strategic Wargaming, which may then support the Army Staff.

The third criterion captures tactical shooter-level models that are used to simulate SOF actions. These models cannot address the important extended and ultimate effects of SOF missions, but they can generate inputs to operational-level models that do address them. This criterion captures such models as SEES and Janus.

CANDIDATE MODELS

The selection process yielded 20 candidate models, displayed in Appendix C. These models appear scattered throughout Section 4 in the context of their users. Here they are presented individually with a brief description, including the general character of the model, sponsor, users, technical data, and an estimate of the support normally required to operate the model.

Air Force Command Exercise System (ACES)

ACES is a theater-level hexagon-based game supported by a stochastic model engine that originated from BDM's Command Readiness Exercise System (CRES) game.[2] ACES is currently being developed by the Air Force Wargaming Center at the Air University to be used for educational war games. Because the data base is unclassified, ACES is unsuited for analytic work, but the model results are credible enough for educational experience.[3]

ACES is an air-land model with some limited naval play, including carrier aircraft, submarines, and some surface-to-surface elements. SOF are explicitly included in the data base. Airborne, heliborne, and infiltration capabilities, but not amphibious assault, are included in the model. The command and control portion of the model does include functional links between organizations, and there is currently an effort to determine the

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[2]CRES is also the parent model of METRIC VI.

[3]Phone interview with Major Dale Shoupe, Air Force Wargaming Center, 11 June 1992.

effects that should be modeled when communications are degraded. In addition, there is an intelligence module that includes some inputs from reconnaissance and overhead sensors.

ACES is written in Fortran, C, and a BDM proprietary language inherited from the CRES version of the model. The Air Force Wargaming Center runs the model on a Cyber 962, and the players view the results on local PCs. There are some plans to convert the system to UNIX.[4]

Corps Battle Simulation (CBS)

CBS is a highly interactive, hexagon-based exercise driver sponsored by the National Simulations Center at TRADOC, and used by JWC and NSC to support theater-level exercises. The CBS level of resolution is that of Blue battalions and Red regiments.

CBS performs simulation of only conventional warfare and does not include any low intensity conflict or representation of weapons of mass destruction. Current CBS-supported exercises represent SOF with controller work arounds, and SOF appear only as very small infantry units with low combat potential. However, the SOF enhancements planned for release in 1992 will capture major aspects of the SR and DA missions. Airborne and heliborne insertion, as well as infiltration, will be modeled.

CBS is based upon an earlier model, originally called JESS, that was sponsored by JWC. The Army continued the development of an air-land version without incorporating Air Force doctrine, which initially prevented its use by the Air Force. There is an on-going program to connect CBS with AWSIM, an Air Force model, which could increase the joint use of CBS. PM Trade has configuration control for CBS, which is written in SIMSCRIPT, FORTRAN, and C, and is run on a VAX.

Concepts Evaluation Model (CEM)

CEM, a theater-level model used to analyze the capabilities and support requirements of Army forces, was developed and is used solely by CAA. It was originally developed 20 years ago to model NATO/Warsaw Pact missions, and it can currently be used for the Central Front, Korea, and Southwest Asia. CEM is an autonomously run, piston-style simulation based on ATCAL methodology. It is written in FORTRAN and can be used on a Cray, Sun, or PC. CAA expects to replace CEM with CTLS.

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[4]Model design information was provided by Lieutenant Colonel Steve Ellertson, Air Force Wargaming Center.

Contingency Force Analysis Wargame (CFAW)

CFAW is a highly interactive, hexagon-based air-land model used at CAA. CAA is the sponsor, developer, and sole user of CFAW, which was developed from the McClintic model. CAA changed the name to CFAW and began development in the early 1980s. CAA plans to replace CFAW with Next Generation Wargame (NXG). Although CFAW was originally used to test OPLANs and support studies for commands, it is currently used for the political-military war games held at CAA several times annually. While it can be run with greater detail, CFAW is usually played at the division level. CFAW is written in FORTRAN and run on the VAX.

Current Theater-Level Simulation (CTLS)

CTLS is an advanced object-oriented model of theater-level conflict under development by CAA. CAA provides high-level design and algorithms for this model, while JPL is responsible for programming. After five years of development, CTLS is now one to two years from release for analytic purposes. The current version (CTLS is frozen twice each year for test purposes) includes ground combat and reconnaissance. C3 is represented by plans that include conditional logic. The air war requires additional development. CTLS is a stochastic, object-oriented, event-driven, network model designed for parallel processing. However, parallel processing may be abandoned because of the prohibitive cost of exploring and using the technology.

Eagle

Eagle is a TRADOC Analysis Command–sponsored project under development. Eagle is currently a division-level object-oriented simulation, which will be expanded to corps level during 1992. Eagle emphasizes command and control and has been used for some force structure analysis in which this capability was useful. It is intended to support analysis of force capabilities. Although TRAC is the primary developer, Mitre and Los Alamos have also contributed. Eagle is written in the List Processing Language (LISP) and is run in UNIX on a Sun microcomputer, but there is a plan to transition to Hewlett-Packard for a better graphics interface. There are currently no intelligence, deployment, or naval components, or any representation of SOF within Eagle.

Enhanced Naval War Gaming System (ENWGS)

Space and Naval Warfare Systems Command (SPAWAR) sponsors development of ENWGS, an interactive model that simulates naval operations at the tactical and operational levels. The ENWGS represents naval air forces and amphibious forces, but it does not

simulate terrain, so amphibious assault is not simulated past the waterline. There is no representation of beach reconnaissance. There are three ENWGS host sites, Naval War College, Tactical Training Group Atlantic (TACTRAGRULAN), and Tactical Training Group Pacific (TACTRAGRUPAC), that can host players or transmit games to the satellite sites. NPS, CINCPACFLT, JWC, NAVWAR, and the two Amphibious Training Schools all have satellite ENWGS capabilities. The Naval War College also hosts exercises for additional groups that do not have ENWGS capability, including the Japanese Navy. ENWGS is written in PL1 programming language and currently operates on a VAX under the Multix operating language. Current plans include rehosting the system into UNIX and Ada. Computer Science Corporation (CSC) is the prime contractor for the development and maintenance of ENWGS.

Force Value Calculator (FVC)

FVC is a spreadsheet model designed and implemented by J8-Force Design Division to evaluate the expected utility of various force structures in environments of peacetime, conflict, and war. FVC is written in Excel and run on the Macintosh. The model produces output in the form of utility curves with strategic force on the y-axis and conventional force on the x-axis. FVC is not currently releasable to any other organizations. Special Forces Groups are represented in FVC, but other special operations forces fall below its level of resolution.

Integrated Theater Engagement Model (ITEM)

ITEM is an object-oriented air-land-sea theater-level model developed by SAIC under the sponsorship of the Defense Nuclear Agency. Users include the Naval War College, SHAPE, and PACOM. The naval portion of the model preceded the air-land portion and was marketed under the name MARITIME. ITEM could be considered representative of an emerging category of models that are object-oriented and relatively user-friendly. The ground methodology includes new maneuver algorithms that are not geographically constrained. Rather, ground forces advance to requested lat/lon positions and orient facing their ground objective. This allows for envelopment and flank attack calculations not found in piston-style models. The Naval War College plans to use the naval model this year, but the air model requires further development for theater-level use. ITEM is written in C++ and runs on a Sun or an IBM PC. The model is currently under development and largely undocumented.

Janus

Janus is a menu-driven, tactical-level model. Developed by Lawrence Livermore National Laboratory, Janus is currently used by MCCDC and NSC to support games and exercises. Janus can simulate DA at the shooter-level.[5] The model uses line-of-sight weapons limited by terrain masking and weapons range. Janus can simulate less typical scenarios, including amphibious assaults, at company battalion-level. The sidebar menus and mouse-driven system make Janus extremely user friendly. Janus is written in FORTRAN and runs on the VAX.

Joint Conflict Model (JCM)

Joint Warfare Center sponsors JCM under development by Lawrence Livermore National Laboratory. JCM is a software suite built on Janus. It is intended to support interactive wargaming and CPX at the level of weapons systems with sufficient aggregation to handle joint task forces. JWC expects to use JCM to support exercises at the level of unified commands. It will simulate a wide variety of user-defined weapons systems in a stochastic simulation based on predefined probabilities of hit and probabilities of kill. JCM will offer editing tools, graphical planning capability, and a regional data base system. It allows creation of SOF and simulation of the SR and DA missions. JCM is written in FORTRAN and runs on any VAX (Micro VAX to VAX 8800).

Joint Theater Level Simulation (JTLS)

JTLS was derived from the earlier Joint Exercise Support System (JESS) model, which was also the original source of CBS. JTLS is a highly interactive hexagon-based game sponsored and used by JWC for exercise support and the Naval Postgraduate School for educational seminar support. The large manpower requirements and the slow run time (typically 4:1) sharply limits its analytic use. JTLS explicitly models ground, air, and naval units. SOF units and the SR and DA missions will be represented in JTLS Version 1.8. JTLS is written in FORTRAN and runs on the VAX.

Panther[6]

Panther is a hybrid of map exercise and automated adjudication used to drive exercises. Units are represented on a mapboard with counters. NSC and USSOUTHCOM

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[5]Janus(L) is the Livermore version and Janus(A) is the Army version of this model. Our evaluation is based on Janus(L). In addition, the Joint Warfare Center is sponsoring development of JCM, a software suite based on Janus.

[6]There are two Panther models in use: Tier 1 and Tier II. Our evaluation is based on Tier I, the more widely used version.

use Panther to support counterinsurgency games in Latin America. The primary measure of effectiveness in Panther is popular support within a given geographic area. The Academy of Health Services at Fort Sam Huston has expressed some interest in using Panther for medical exercises. There is currently an effort to re-write Panther in PASCAL. NSC is currently developing a version with the non-coded elements (headings, prompts, etc.) in Spanish. Panther runs on an IBM PC or compatible, and the NSC team frequently uses laptop computers.

RAND Strategy Assessment System (RSAS)

The RSAS is a deterministic model of global nuclear and conventional combat that was developed by RAND under sponsorship of OSD/NA. A new release version of the RSAS, known as the RSAS Integrated Theater Model (RSAS ITM), reached prototype stage during the summer of 1992.[7] RSAS includes data for most of the world's military forces and global geography. RSAS ITM will support simultaneous simulation of theater-level operations in Europe, the Near East, Southwest Asia, and Korea, including a realistic model of U.S. strategic mobility. RSAS ITM represents SOF teams and adjudicates some SR and DA tasks. RAND has used RSAS to support analytic studies on a wide variety of military issues, ranging from nuclear exchanges to regional balances of military power. RSAS is used to support wargaming conducted at the National Defense University, Army War College, Air University, Naval War College, and the Naval Postgraduate School. RSAS is also used to support the annual JLASS game sponsored by the senior Service schools and the annual Global War Game, sponsored and hosted by the Naval War College. RAND normally provides operators to support major war games. RSAS ITM is written in C and Anabel[8] and runs on a Sun-4 microcomputer.

Regional Development Simulation System (RDSS)

JS is sponsoring the development of RDSS by Booz, Allen & Hamilton, Inc., with RAND acting in an advisory role. The prototype form of RDSS supports an LIC war game, called "Island Reach," sponsored by J8. USSOUTHCOM will become a beta user when the model is released. RDSS is a unique simulation of political, economic, social, and military affairs, in a single country, over a timeframe of five to ten years, with a flow methodology

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[7]RSAS-ITM integrated the former CAMPAIGN-MT and CAMPAIGN-ALT into a single representation of theater-level conflict with ground combat simulated on a network rather than separate axes. In addition, RSAS-ITM included better representation of SOF performing direct action. Hereafter, RSAS-ITM will be evaluated as the candidate model.

[8]Anabel is an object-oriented version of RAND-ABEL, a RAND-developed language used for previous RSAS versions and other applications.

based on resource allocations. The precursor of RDSS was developed under contract from the U.S. Government following the Iranian revolution to examine individual third-world countries for evidence of instability and predictions of major upheavals. Based on this experience, Booz, Allen & Hamilton, Inc., developed a more generalized model of country-level instability. RDSS is written in iThink™ (formerly Stella™), a high-level language based on a flow diagram that is largely self-documenting if the variables are well defined. Simultaneous differential equations are used to solve iThink. The size limitations of iThink have required the use of a compiler, creating potential differences between the compiled code and the iThink code displayed to the user. RDSS runs on the Macintosh.

TAC Resource Allocation Model (TAC RAM)

TAC RAM is an apex model that uses input from various other sources, including higher resolution models, to produce a theater-level simulation of an air campaign. Effectiveness of a campaign is measured in number of ground attack sorties.[9] Although TAC RAM does include intelligence simulation from sensors such as AWACS, there is no representation of SOF in a special reconnaissance role. TAC RAM is sponsored by AFSAA and was programmed internally, although Booz, Allen & Hamilton, Inc., is developing a C3I portion for the model. TAC RAM is written in iThink, a flow model programming language, and run on the Macintosh.

Tac Thunder

Tac Thunder was developed by CACI Products Company under the sponsorship of AFSAA. CACI developed the model from methodology provided from the Services. The Army provided the ATCAL methodology inherent in CEM. The Air Force designed the air war and provided the weather model. CACI exercises configuration control and accomplishes development under guidance of the users' group. The ground war is a pure piston-style model. The air war is well detailed at the theater level and includes 24 different air missions (sorted by mission and basic target type). There is no explicit representation of SOF or special operations. Tac Thunder is written in SIMSCRIPT and runs on a Sun microcomputer.

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[9]This measure of effectiveness is based on the assumption that combat aircraft exist to perform a ground attack role, and that other missions are flown to gain air superiority so ground attack sorties can be flown.

Tactical Warfare (TACWAR)

TACWAR is an autonomous, piston-style theater-level model originally developed by the Institute for Defense Analysis. TACWAR is sponsored by J8-CFAD and used by J8 and USCENTCOM for capabilities analysis. TRAC uses TACWAR to develop TRADOC approved scenarios to support force planning. Maneuver warfare is not modeled, and tactical air is represented only by its effects upon the ground battle. Naval forces, strategic mobility, command and control, and intelligence are not included in the model. SOF and special operations are not simulated. TACWAR is written in FORTRAN and normally runs on the VAX, however the Institute for Defense Analysis runs TACWAR on a PC. The PC version has a reduced memory requirement because data is aggregated in spreadsheets.

Tactical Warfare Simulation, Evaluation, & Analysis Model (TWSEAS)

TWSEAS is a highly interactive simulation tool used by the Marine Corps to support real-time command post exercises at the MEB and MEF levels. TWSEAS is currently used to support active-duty and reservist training at Quantico. It is also available at MEF headquarters at LeJeune, Pendleton, and Okinawa, and in the amphibious warfare schools at Little Creek and Coronado. The joint aspects of TWSEAS are limited. There is a program in development at MCCDC to provide Army and Air Force officers to play other Service components, but their contribution to the exercises would be off-line. There is some limited SOF play in TWSEAS in the form of reconnaissance teams whose reports add to the intelligence provided on enemy force, and who can call in air strikes against the enemy, but the amount of SOF played depends very heavily upon the exercise controllers. TWSEAS-M is currently being written in Ada. The model runs on the VAX.

Theater Assessment Model (TAM)

TAM is sponsored by J8-PMAD and is used by USAWC, NWC, and TRAC for rapid, first-cut analysis of theater-level conflict. International users include the British MOD, Sandhurst, the French MOD, and the Canadian Defense College, which wrote and published the TAM analyst's guide. Direct action missions are currently represented by some users with a "super munition" that causes the damage to the target with no entry cost. TAM is a highly interactive decision aid. It is written in Ada, operates within the MS-DOS environment, and can be run on any IBM PC or compatible.

CATEGORIZATION OF MODELS

The decision aids encountered during our survey have widely different characters, depending on sponsorship, purpose, and choice of method. Some are special purpose models

designed to satisfy a requirement peculiar to the using agency. The apex model TAC RAM, which ranks alternative air forces according to a single measure of effectiveness, is a special purpose model. It is intended to provide rapid, first-cut analysis[10] of the Air Force Program Objective Memorandum and is unlikely to have wider application. Another example is FVC, which quantifies expert judgments on the utility of alternative force structures. It supported analysis of the base force and may continue to provide insights at an extremely high level of force aggregation, but it is unlikely to be used outside of the Joint Staff. Some FVCs employ unique methodologies. Panther, for example, is unique in fusing a map exercise with a computer-generated adjudication of combat. Although this fusion is the model's major strength, NSC encounters resistance from users who consider Panther insufficiently high tech.[11] Another unique model is RDSS, which supports analysis of country-level stability as a function of resource allocation decisions. No other model encountered during our survey provides such a vehicle for analysis.[12]

Leaving unique and special purpose models aside, the combat models encountered in the survey can be usefully arrayed according to the level of operations: tactical level, taskforce level, and theater level. Ascending this hierarchy, one encounters increasing complexity and interaction among disparate force elements. The theater-level models fall into three categories: (1) interactive exercise drivers, (2) semi-autonomous models, and (3) autonomous, piston-style models. An exercise driver is designed to support command post exercises. It requires extensive human interaction and provides rapid adjudications of combat without much concern for analytic validity. A semi-autonomous model is designed to run interactively until the operator is satisfied that he has identified key issues. Thereafter, a semi-autonomous model may be run iteratively to support analysis. An autonomous model is designed to run without human interaction although some interaction may be allowed. Piston style implies that maneuver is restricted to advance or retreat on a major axis according to adjudication of combat. Figure 5.1 presents models by category, with the theater-level categories highlighted.

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[10]The overview briefing for TAC RAM humorously shows a hammer driving a screw with the motto: "TAC RAM, the model of choice when you want it REAL BAD!" Briefing, "TAC RAM Resource Allocation Model," Air Force Studies and Analyses Agency, October 1, 1991.

[11]Interview, Major Richard D. Koone (USA), Panther manager, National Simulation Center, February 4, 1992.

[12]Castellon, the model most similar to RDSS, is a simple seminar-driver unsuited to analytic work.

Theater-level combat: interactive exercise drivers	Contingency Force Analysis Wargame (CFAW) Corps Battle Simulation/Joint Exercise Support System (CBS/JESS) Joint Theater Level Simulation (JTLS)	
Theater-level combat: semi-autonomous models	Eagle Integrated Theater Engagement Model (ITEM) Current Theater Level Simulation (CTLS) RAND Strategy Assessment System-Integrated Theater Model (RSAS-ITM)	
Theater-level combat: autonomous, piston-driven models	Concepts Evaluation Model (CEM) Tac Thunder Tactical Warfare (TACWAR) [Theater Assessment Model (TAM)]*	*Although piston-driven, TAM is currently a highly interactive model.
Taskforce-level combat	Joint Conflict Model (JCM) Enhanced Naval Wargame System (ENWGS) Tactical Warfare Simulation, Evaluation, & Analysis System (TWSEAS)	
Tactical-level combat	Security Exercise Evaluation Simulator (SEES) Janus	

Figure 5.1—Models by Category

At a tactical level, models such as SEES and Janus simulate combat by pairing shooters with targets. Models in this category support gaming and analysis of small unit actions employing either conventional forces or SOF. The outputs of these simulations may become the inputs for models at higher levels. At taskforce level, models such as ENWGS and TWSEAS simulate combat employing joint forces aggregated to unit levels, while stopping short of a fully developed theater. The JCM program is intended to develop a taskforce-level suite from a tactical model (Janus) through aggregation and peripheral software.

Autonomous, piston-driven models, such as CEM, Tac Thunder, and TACWAR, are designed to analyze combat in iterative fashion. Models in this category are typically run in batch mode—i.e., successive runs each with some narrowly defined difference from its predecessor. TAM offers an unusual combination of piston-driven modeling and high interaction in order to obtain a rapid first look at a theater. A number of newer models, including Eagle, ITEM, CTLS, and RSAS ITM, are semi-autonomous. They are typically used in an interactive gaming mode until the user is satisfied that he has identified the major issues of a campaign or the key parameters of a problem. Thereafter, they may be run autonomously in batch mode to support detailed analysis. These models use various geometries for ground combat, including pistons, hexagons, and networks. In the last

category are those models that are interactive and hexagon based. These include the JESS derivatives, CBS and JTLS, as well as CFAW. They are designed for gaming and cannot be used iteratively except at a prohibitive price in time and manpower. However, these models tend to provide the most inclusive simulation of SOF actions at the tactical and operational levels.

6. ASSESSMENT OF ADEQUACY

In assessing adequacy, we first considered each candidate's coverage of the five basic SOF missions described in Section 2. This step is not as straightforward as it might appear. Experienced model users, especially those with programming skills, contrive to cover SOF missions in a variety of ways. They may perform an off-line analysis and input the results of a model by changing variables, parameters, or outputs to reflect the off-line analysis. The off-line analysis may be entirely manual or it may be supported by a tactical level model, such as Janus. SOF play may be scripted by making arbitrary changes in adjudication accompanied with comments to analysts and players. Work arounds or "kludges," may be employed to create weapons or conditions intended to capture the effects of SOF. During war games, model users may provide intelligence that is ascribed to SOF. These efforts can provide fruitful hints for further development, but they are not germane to an assessment of coverage. They tell more about the creativity of model users than about the adequacy of models. To avoid this distraction, we have confined our assessment to the existing features of the models, including development and enhancements scheduled for release during 1992. Figure 6.1 summarizes current coverage.

ASSESSMENT BY MISSION

Counterterrorism

None of the candidates covers counterterrorism. It is tempting to claim that shooter-level models cover this mission because they are employed to evaluate vulnerability and to conduct war games involving terrorists. For example, SEES was originally developed exactly for the purpose of evaluating the security of nuclear installations against terrorist attack. However, these models do not adequately represent all the tactical aspects of the mission, such as intelligence preparation, host nation support, political constraints, and special techniques. More important, analysis at the tactical level includes only immediate effects such as the recovery of uninjured hostages. Of greater importance are extended and ultimate effects, especially the perception that the United States can and will respond to combat terrorism effectively. It would be extremely misleading to suggest that a model covers counterterrorism when it merely simulates some aspect of the combat involved.

Model	CT	Special reconnaissance			Direct action			UW	FID
		Beach	Strike	Conven-tional	Destroy	Occupy	Recover		
ACES									
CBS			explicit	explicit	explicit	explicit			
CEM									
CFAW			explicit	explicit	explicit				
CTLS									
Eagle									
ENWGS		scripted							
ITEM									
Janus					explicit	explicit			
JCM				explicit	explicit	explicit			
JTLS			explicit	explicit	explicit	explicit			
Panther									explicit
RDSS									implicit
RSAS-ITM					explicit	explicit			
SEES					explicit	explicit			
TAC RAM									
Tac Thunder									
TACWAR									
TWSEAS-M		scripted	explicit	explicit					
TAM									

Figure 6.1—Coverage of SOF Missions

Special Reconnaissance

As shown in Section 3, special reconnaissance must be analyzed at the level of illustrative tasks. We assessed each candidate's coverage of three illustrative tasks within the SR mission: hydrographic or beach reconnaissance, strike reconnaissance, and reconnaissance against conventional forces. Not even the Navy's amphibious assault models, ENWGS and TWSEAS, explicitly simulate beach reconnaissance, but they are adapted to scripting this mission. This scripting is noted in our assessment because it is a normal, expected element in war games supported by these models. Strike reconnaissance and reconnaissance against conventional forces can be simulated only within a model that allows asymmetrical intelligence. If intelligence is symmetrical or not played, these tasks have no meaning. In the current state of modeling, only the interactive exercise drivers, CBS, CFAW, JCM, JTLS, and TWSEAS plus ACES normally play asymmetrical intelligence and simulate the SR mission. CFAW offers a simple representation of strike reconnaissance in the "INTEL" order, which allows a player to deploy an undetectable human source of intelligence to a designated hexagon. This nominal source could be a civilian agent or an SOF team. TWSEAS is limited to targets within range of artillery, helicopters, and fixed-wing aircraft in

close support, but not flying deep interdiction. These models and JCM cover reconnaissance directed against conventional forces. Note that this task implies relatively free maneuver of ground forces; if maneuver is stereotyped or restricted, then reconnaissance against conventional forces loses its value.

Direct Action

Direct action must also be analyzed at the level of illustrative tasks: destruction of key targets, occupation of key facilities, and capture or recovery of personnel and materiel. It is no surprise that destruction of key targets is the SOF task covered by the largest number of models. Destruction of key targets is covered by the exercise drivers, the tactical-level models, and a couple of the semi-autonomous models. However, the tactical level models simulate only immediate effects. Also, there is wide variance among these models concerning insertion method and range of potential targets. CFAW, for example, allows only undetected insertion, while CBS and JTLS, with the planned SOF enhancement, will adjudicate detection using stochastic detection algorithms. RSAS ITM will direct SOF primarily against force targets, while CBS and JTLS will also allow direct action against objects such as bridges in the rear area. None of the candidates simulates direct action against command and control facilities in a realistic fashion. The same models, less CFAW, cover the task of occupying key facilities. However, the combat power of SOF is problematic for modelers. If only weapons scores are considered, the smallest conventional force can quickly and easily destroy SOF in the strength in which a conventional force is normally employed. It is trivial to arbitrarily increase the combat power of SOF as shooters, but the problem runs deeper. SOF also derive increased combat power from extremely close air support, sometimes employing specialized aircraft, such as the AC-130, a relationship that is not easily modeled. None of the candidates covers the task of capturing or recovering personnel and materiel.

Unconventional Warfare

None of the candidates covers the unconventional warfare mission, except in the sense that Panther or RDSS might be "stood on its head,"—i.e., considered from insurgent perspective. However, both these models were clearly designed with FID, not UW, in mind, probably because U.S. forces have a much closer historical association with FID than UW.[1] In addition, the elusive, quicksilver nature of unconventional warfare makes it difficult to quantify or reduce to a system.

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[1]As examples of FID, one can adduce postwar Greece, Korea, Vietnam, and several Latin American countries. By contrast, the best known examples of UW date to WWII.

Foreign Internal Defense

Two models offer some coverage of FID. Panther explicitly simulates two included tasks: interdiction of insurgent routes and destruction of insurgent forces and bases. However, this simulation is designed for gaming, not analysis. RDSS is a dynamic simulation that considers political, social, and economic, as well as military factors, including combat against insurgents, civil affairs, psychological operations, and intelligence gathering. It implicitly models SOF by considering factors directly related to the FID mission, while not explicitly modeling the forces.

PROBLEMS IN MILITARY MODELING

In addition to the issue of general lack of coverage for the various SOF missions, there are additional problems inherent in military modeling. In its current state, military modeling exhibits problems that are likely to attract increased attention.[2] To address these problems in systematic fashion would exceed the bounds of this project. However, our survey revealed several problems with important implications for SOF.

Lack of Interoperability

Current combat models were developed under the sponsorship of OSD, the Services, and Service-related analytic agencies with little regard for interoperability within a Service, much less across Service lines. Among the Services, the Army exhibits the strongest concern for interoperability, but even the Army has abandoned its attempt to produce a hierarchy of interoperable models. Instead, the U.S. Army Model Improvement and Study Management Agency (MISMA) tries to promote "correspondence" among the various models sponsored within the Army.[3] The other Services lack a counterpart to MISMA. The Under Secretary of Defense for Acquisition has recently created the Defense Modeling and Simulation Office (DMSO) charged with framing policy for model development with an emphasis on interoperability. Even if this initiative is highly successful, progress is likely to be slow. Lack of interoperability, especially among theater-level models, has an obvious implication for special operations: To ensure a representation throughout existing models would require

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[2]Recent RAND publications on this topic include: James S. Hodges, *Six (or So) Things You Can Do with a Bad Model*, RAND, N-3381-RC, 1991; Paul K. Davis and Donald Blumenthal, *The Base-of-Sand Problem: A White Paper on the State of Military Combat Modeling*, RAND, N-3148-OSD/DARPA, 1991. For an overview that is still valid, although its data has become obsolete, see Gary D. Brewery and Martin Shubik, *The War Game, A Critique of Military Problem Solving*, Harvard University Press, 1979.

[3]Interview, Lana E. McGlynn, operations research analyst, U.S. Army Model Improvement and Study Management Agency, November 25, 1991.

either numerous independently developed SOF modules or numerous interface mechanisms that would be of comparable complexity.

Turbulence

Military modeling might be expected to exhibit considerable turbulence as models emerge, mature, and decline before they are replaced by newer models. During the course of the survey, we found important new starts, extensive further development of existing models, and expected replacements. This turbulence was especially noticeable at CAA, where CTLS is expected to replace CEM and NXG to replace CFAW. Among the important new starts were ACES, Eagle, ITEM, and RDSS. Most of the established models are currently undergoing extensive further development. The list of such models includes CBS, ENWGS, Janus (in several versions), JTLS, Panther, RSAS ITM, and TWSEAS. In some instances, such as RSAS ITM, this further development will involve fundamental changes to the model. While certainly healthy in itself, this turbulence poses problems for any proposal to improve the representation of special operations. Existing models are changing rapidly, and it is unclear which ones will be most successful and extensively used.

Adaptation to Post-1989 Issues

Some of the current combat models were designed to analyze pre-1989 issues, which were dominated by the central front in Europe. They are well adapted to simulations of combat between large formations across a wide front in battles of attrition. CEM, TACWAR, and Tac Thunder are models of this character. In their current state, they are less well adapted to consideration of regional conflicts that are likely to emphasize such issues as strategic mobility, forced entry, air interdiction, strategic air campaigns, and maneuver warfare with limited attrition to U.S. forces. If they are retained, models originally designed to analyze the central front will require extensive new development. From an SOF perspective, such development would be significant, because post-1989 issues are more relevant to special operations than were the issues traditionally associated with the central front.

SUMMARY

Special operations forces are inadequately covered by existing decision aids. Two missions, counterterrorism and unconventional warfare, are not covered at all, probably because of their elusive nature. One mission, foreign internal defense, is partially covered from two extremely different perspectives. Two missions, special reconnaissance and direct

action, are partially covered by exercise drivers that are very manpower intensive and by tactical models that miss their important effects.

Current combat modeling exhibits a lack of interoperability across Service lines, turbulence caused by on-going development, and an incomplete adaptation to post-1989 issues involving regional conflicts. Lack of interoperability across Service lines is a serious problem for SOF, which are inherently joint in nature. Turbulence makes it difficult to assess which models will be of greatest importance for the representation of SOF. However, increasing adaptation to the post-1989 era is a hopeful development from the SOF perspective because post-1989 issues are more relevant to special operations than were the issues associated with analysis of the central front in Europe.

7. COMPARATIVE EVALUATION OF THEATER-LEVEL CANDIDATES

EVALUATION METHODOLOGY

Theater-level candidates are of special interest because they model the operational level of war and are directly comparable. We evaluated the theater-level candidates in three categories: relevance to special operations, acceptance, and viability. Figure 7.1 gives an overview of this methodology. Within each category, we posed a series of questions with numerically scored answers reprinted in Appendix D.

Relevance to Special Operations Forces

Relevance to special operations forces evaluates how well the model handles areas where the effects of SOF are felt, independent of the current coverage of SOF missions. We have already seen that coverage is inadequate. Here, we address the question of any theater model's intrinsic ability to address SOF issues at all. Relevance to special operations forces is subdivided into the operational level of war; joint and combined forces; command, control,

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Relevance to special operations:
- Operational level of war
- Joint and combined forces
- C3I
- Movement and maneuver
- Unconventional warfare
- Political, economic, and social factors

How well does this model address areas of SOF effect?

Acceptance:
- Agreement with
  - Service doctrine
  - Actual events
- Accreditation
  - De jure (official)
  - De facto (use)

What agencies currently accept this model?

Viability:
- Technical freshness
  - Language
  - Architecture
- Transparency
- User friendliness
  - Ease in learning
  - Ease of startup
  - Character of interface
- Adaptation to post-1989

How appropriate is this model for widespread use?

Figure 7.1—Evaluation Methodology

communications, and intelligence; movement and maneuver; unconventional warfare; and political, economic, and social factors.

Operational Level of War. The extended and ultimate effects of SOF are usually felt at the operational level of war in the context of larger conventional forces. The operational level of war is reflected in the way achievement of campaign objectives is evaluated, an appropriate geographic area, and the size of the deployed forces. A realistic evaluation of success in achieving campaign objectives should include forces, explicit geography, and some modeling of national entities. The most appropriate geographic area is an entire theater of operations, generally a region such as Southwest Asia. Ideally, the forces should include all those forces normally deployed to a mature theater, including support units.

Joint and Combined Forces. The model's ability to handle joint and combined forces is crucial to realistic operations and to Special Operations Forces, which are inherently joint forces and are often combined forces. Modeling joint and combined forces implies consideration of air-land-sea forces, the synergism of air-land operations, the synergism of amphibious operations with ground operations, and the representation of foreign forces at different levels of training. For example, strike reconnaissance has little meaning in a model that does not capture the synergistic effect of air-land operations. Hydrographic reconnaissance is irrelevant in a model that does not allow amphibious assault. The important SOF role in training indigenous forces is lost in a model that treats forces uniformly regardless of origin.

Command, Control, Communications, and Intelligence. C3I is fundamental to the evaluation of two SOF missions. First, the special reconnaissance mission can be simulated only within the context of control mechanisms and intelligence collection. Second, direct action is often conducted against opposing command posts and communications facilities. If these entities are not represented, then SOF cannot attack its most lucrative targets.

Movement and Maneuver. Worldwide mobility is important because SOF should be credited for their ability to move rapidly with minimal lift assets. In immature theaters, SOF may assume critical importance pending the arrival of larger forces. In-theater movement and maneuver are important both to simulate SOF insertion and to evaluate SR conducted against conventional forces. If these forces cannot maneuver realistically within the model, then conventional forces reconnaissance has little value.

Unconventional Warfare. It would be unreasonable to expect any model to capture the richness of unconventional warfare in its entirety, but our evaluation does include tests

for infiltration, raiding tactics, and consideration of the effect of popular support upon operations. Raiding is characterized by the sudden arrival of small forces, brief combat, and withdrawal in the pattern set by British commando units. Raids may predominate during unconventional war and are a normal accompaniment of conventional war.

Political, Economic, and Social Factors. Lastly, we consider how well a model handles country alignments, damage to infrastructure, military aptitude and morale, government popularity, and the influence exerted by social groups. To illustrate the importance of country alignment, there is little value in simulating SOF action against Iraqi ballistic missiles within a model that cannot simulate Israel's entry into the war. Damage to infrastructure is an SOF speciality, falling under the DA mission.

Acceptance

We briefly evaluated acceptance from two perspectives. First we considered how well a model accords with Service doctrine or has been correlated with real-world events. Regarding Service doctrine, a model received the highest rating if it fully agreed with the doctrine of two Services. Correlation with real world events is a subjective judgment. To our knowledge, none of the large combat models has been correlated in the sense of replicating an historical campaign.[1] Second, we considered de jure and de facto accreditation of a model. De jure accreditation implies that an official agency associated with the Joint Staff or a military Service has examined a model and officially authorized its uses for some explicit purposes. De facto accreditation reduces to acceptance through use and is normal for military models.

Viability

Finally, we evaluated the viability of the model—i.e., the general likelihood of continued and expanded use, as a function of its technical aspects and user friendliness. On the technical side, we considered its language and architecture, its transparency as reflected in the quality of documentation, and its adaptation to the regional conflicts expected to dominate post-1989 military planning. For example, a model received the highest score for technical freshness if written in a newer generation language and based on an object-oriented design. Under user friendliness, we considered ease in learning the model, the effort required to start up a new scenario, and the quality of interface with the operator. A

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[1]We tried to avoid the contentious issues of verification and validation of models. In a strict sense, no large combat model can be validated anyway. It is not even clear that correlation can be accomplished in a thorough, convincing manner. Certainly, a skillful user can tune a large combat model until it produces the results of an actual war, but such an ex post facto exercise would not prove that the model's algorithms captured the dynamics of combat.

model received the highest rating if it provided a state-of-the-art interface that included a window environment, menu-driven operation, on-line helps, and data base management tools.

EVALUATION RESULTS

Nine theater-level models were evaluated: ACES, CBS, CEM, CFAW, ITEM, RSAS ITM, Tac Thunder, TACWAR, and TAM.[2] Figure 7.2 below displays their relative scores for relevance to special operations. As explained above, relevance includes evaluating the model's inherent ability to address areas of interest to special operations, *not* its current simulation of special operations, which may be nil. It is suggestive that no model scored higher than 50 percent, but the absolute scale of these rankings is arbitrary. One could make greater or lesser demands on the models and create different impressions. The relative scores are important; we are reasonably confident that they reflect the models' relative capabilities to address areas of inherent SOF interest.
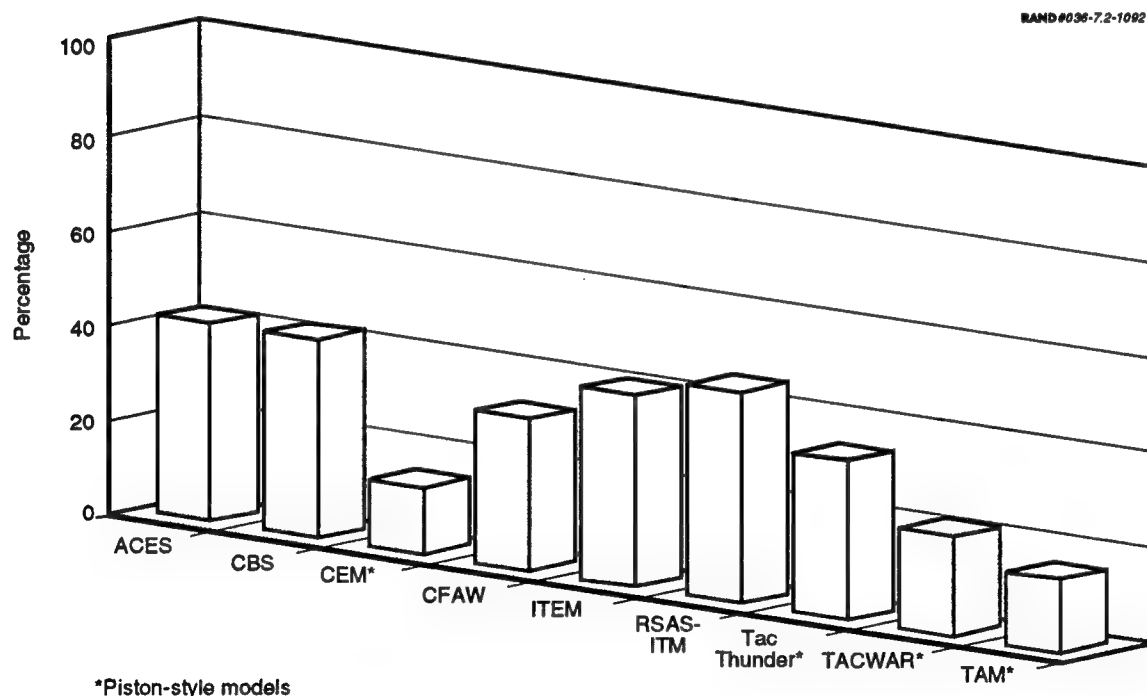

Figure 7.2—Partial Evaluation: Relevance to SOF

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[2]In view of the close relationship between CBS and JTLS, we selected the more widely used CBS to represent both models. We were unable to evaluate CTLS and Eagle because these models are still undergoing basic development and are undocumented. Of the nine models evaluated, four (ACES, CBS, ITEM, RSAS ITM) will shortly receive important enhancements. We included enhancements that were funded and scheduled for release by the end of 1992.

Three observations emerge from this evaluation. First, interactive exercise drivers, such as CBS, score high, as might be expected. It is not surprising that high investment in skilled manpower, both players and operators, correlates with the ability to handle a difficult issue like special operations. Second, piston-style models (CEM, TACWAR, TAM, and to some extent Tac Thunder) tend to have low scores. This result might also be expected. Piston-style modeling of attrition warfare is antithetic to SOF whose advantages are agility and the highly selective application of combat power. Third, newer models that attempt to satisfy the conflicting demands of wargaming and iterative analysis (ITEM, ACES, RSAS ITM) appear almost as relevant as the interactive exercise drivers.[3]

Evaluation of the nine theater-level candidates in all categories is displayed in Figure 7.3. Again, absolute scoring is arbitrary, but the relative scores provide valid insights.

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*Piston-style models

Figure 7.3—Overall Evaluation: Relevance, Acceptance, Viability

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[3]The authors have extensive exposure to RSAS. Meg Cecchine is editor of the *RSAS Newsletter* and conducts training for RSAS operators. Bruce Pirnie contributed to RSAS development over several years, especially to the representation of theaters outside central Europe. Both operate RSAS to support wargaming and for analytic purposes. However, the evaluation of models was accomplished against a set of definite criteria listed in Appendix D.

It is immediately apparent that a model's relevance to SOF correlates poorly with the model's acceptance. Several models with low relevance (CEM, TACWAR, and to some extent Tac Thunder) have high acceptance. On the other hand, two semi-autonomous models with high relevance (ITEM and RSAS ITM) have low acceptance. As explained above, acceptance or de facto accreditation is linked to use and sponsorship. For example, TACWAR benefits from its use by the Joint Staff and USCENTCOM. There is much better correlation between relevance and viability. It is noteworthy that no model with high relevance has low viability. This correlation suggests that a model that is sufficiently sophisticated to address SOF issues is likely to be technically advanced and user friendly as well. However, high viability does not imply high relevance, as the example of TAM makes clear. This deliberately simple model trades capability, and hence relevance to SOF, for viability as reflected in quick startup and low overhead costs.

The theater-level candidates included in this evaluation have widely disparate support requirements and analytic capabilities.[4] These two aspects are related. An exercise driver like CBS requires the efforts of hundreds of people, many highly skilled in military operations, to run just one game. This heavy support requirement is acceptable in an exercise driver, but it precludes the iteration necessary for analytic use. On the other hand, an autonomous attrition model like TACWAR requires only a small team, generally on the order of two to five skilled operators, and is well suited for iterative analysis. Models of this character allow the operators to run series of games for analytic purposes, typically varying force structure or assumptions about weapons effectiveness. They easily generate so much output that its management can become a major problem. Semi-autonomous models that are less data intensive, such as RSAS ITM, may require one to three skilled operators. They have high relevance to SOF issues and permit iterative use for analysis, but currently have low acceptance.

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[4]These disparities are so great that general comparisons of these models would be extremely difficult. All of the theater-level models discussed above, with the possible exceptions of CFAW and TAM, are complex and tend to evolve at rates that make intimate knowledge ephemeral. They were developed for different purposes, reflect different perspectives, and serve different needs. We emphasize that the evaluations reflected in this Note are based solely on the evaluation criteria reflected in Appendix D. We consider these criteria adequate for the purposes of this study, but they would not support more general comparisons of theater-level models, nor should our evaluations be construed as offering such comparisons.

8. CONCLUSIONS

INADEQUATE COVERAGE OF SOF MISSIONS

Current decision aids are inadequate for analysis of SOF missions. No model addresses counterterrorism or unconventional warfare, except in the sense of simulating tactical-level combat. Strategic reconnaissance and direct action are partially covered, but not by models that currently support capabilities analysis. Two models, Panther and RDSS, partially cover the mission of foreign internal defense.

Tactical-level models simulate the combat actions associated with counterterrorism, but they do not support analysis of the mission. In themselves, these combat actions are indistinguishable from direct action and do not provide a basis to analyze counterterrorism. To analyze this mission, one must ask fundamental questions about the national interest in defending the lives of Americans abroad and the deterrent effect of military capability.

Strategic reconnaissance and direct action are the easiest missions to model because they are most closely associated with conventional force operations. The currently programmed enhancements to exercise drivers will allow fairly realistic play of these missions during command post exercises, and some newer theater-level models will partially cover these missions. However, they are not covered by any of the models currently used for capabilities analysis within the Joint Staff and the analytic agencies supporting Service staffs. In fact, the most widely accepted analytic models have the least relevance to SOF issues.[1]

Tactical-level models can simulate the combat associated with unconventional warfare, but they contribute little to analysis of other aspects such as intelligence collection, escape and evasion, subversion, and sabotage. Nor can they address fundamental issues, such as indigenous support to the insurgents. It would be profoundly misleading to suggest that any simulation of tactical combat provides an adequate basis to analyze the complicated phenomenon of unconventional warfare.

Two models address foreign internal defense from opposite modeling perspectives. Panther presents a micro view simulating small units in pursuit of guerrilla forces. This simulation is intended to drive exercises, not to be analytically valid. RDSS takes a macro view, presenting a country's entire situation at the level of national resource allocations. If

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[1]We do not intend this conclusion to be a pejorative judgment on such models as CEM, TACWAR, and TAM. These models were designed to analyze protracted large scale combat between conventional forces and should be judged in that context.

successful, RDSS may produce useful insights into environments where SOF might have to operate, without explicitly simulating its actions. The strong contrast between the perspectives of these two models may not be accidental. It suggests that this crucial SOF mission is tractable at the small unit-level and perhaps at a high level of abstraction, but it is too difficult in its entirety.

DILEMMA IN MODELING SPECIAL RECONNAISSANCE AND DIRECT ACTION

The survey revealed that counterterrorism is not modeled, except in the sense that shooter-level models may simulate some aspects of tasks such as hostage rescue. Considering the great uncertainty that surrounds CT, especially the nature of the terrorist threat, this omission is not surprising. Similarly, lack of clear causal relationships and paucity of reliable data may be insurmountable bars to successful modeling of FID and UW, except at the extremes of tactical engagement and countrywide parametric analysis.[2] SR and DA are best modeled because they are most closely associated with conventional combat, but even these missions present a dilemma for analysis.

The dilemma springs from the widely different characters of combat models, their relevance to SOF, and utility for analysis. Broadly stated, interactive exercise drivers are most relevant to these missions and currently provide the best coverage. Semi-autonomous models are moderately relevant, while autonomous, piston-style models are least relevant. However, the interactive exercise drivers are unsuited to the iteration typically required to analyze capabilities and so are not used for this purpose. If one considers the current degree of acceptance, the dilemma becomes more complex. The exercise drivers and the autonomous, piston-style models are widely accepted and used, the former to drive exercises and the latter to analyze capabilities. Semi-autonomous models, including some just emerging from development, might offer a middle way between these extremes, but these do not currently enjoy wide acceptance. Figure 8.1 puts this dilemma in succinct form.

There is little prospect that interactive exercise drivers will be able to support iterative analysis. There is no short-term prospect that the autonomous, piston-style models will become more relevant to special reconnaissance and direct action. We have no basis to predict how well the newer semi-autonomous models will emerge from development or how widely they will be accepted. However, as military modeling adapts to the post-1989 security environment, it should become increasingly useful for SOF analysis. Such issues as

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[2]In Task 3 of this project, we will attempt to judge, in a comprehensive way, which SOF missions or portions of missions are unsuitable subjects for modeling in the current state of the art.

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	Relevance to SR and DA?	Suitable for iterative analysis?	Currently enjoy wide acceptance?
Interactive exercise drivers (CBS, JCM, JTLS)	High	No	Yes
Semi-autonomous models (CTLS, Eagle, ITEM, RSAS)	Moderate	Yes	No
Autonomous piston-style models (CEM, Tac Thunder, TACWAR)	Low	Yes	Yes

Figure 8.1—Dilemma in Modeling Special Reconnaissance and Direct Action

command and control, intelligence, maneuver warfare, deep fires, and the disparate qualities of national forces are not exclusively associated with SOF. These issues are also critical to analysis of other joint operations in regional conflicts.

Appendix A
SPECIAL OPERATIONS FORCES[1]

U.S. ARMY SPECIAL OPERATIONS COMMAND
Forward deployed units

1st Battalion, 1st Special Forces Group (Airborne), Okinawa

1st Battalion, 10th Special Forces Group (Airborne), Germany

Company C, 3rd Battalion, 7th Special Forces Group (Airborne), Panama

Detachment K, 1st Special Forces Group (Airborne), South Korea

617th Special Operations Aviation Detachment (Airborne), Panama

U.S. Army Special Operations Integration Command (Airborne)

75th Ranger Regiment, Fort Benning, Georgia

160th Special Operations Aviation Regiment (Airborne), Fort Campbell, Kentucky: OH-6,
      CH-47, MH-60 (one battalion at Hunter Army Airbase, Georgia)

1st Battalion, 245th Aviation (Airborne), Tulsa, Oklahoma (National Guard)

U.S. Army Special Forces Command (Airborne)

1st Special Forces Group (Airborne), Fort Lewis, Washington

3rd Special Forces Group (Airborne), Fort Bragg, North Carolina

5th Special Forces Group (Airborne), Fort Campbell, Kentucky

7th Special Forces Group (Airborne), Fort Bragg, North Carolina

10th Special Forces Group (Airborne), Fort Devens, Massachusetts

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[1]This list was compiled from open sources to give the non-specialist an overview of current SOF. Army forces from Interview, Lieutenant General Wayne A. Downing (USA), Commander, Army Special Operations Command, reprinted as "A Force of 'Great Utility' That Cannot Be Mass-Produced," *Army*, April 1992, pp. 25–33. Air Force forces from *Air Force Magazine*, May 1992, pp. 80–81. Navy forces from Kevin Dockery, *SEALS in Action*, Avon Books, 1991, pp. 346–347; and James R. Locher III and Carl W. Stiner, *United States Special Operations Forces Posture Statement*, June 1992, pp. C-4 to C-5.

11th Special Forces Group (Airborne), Fort Meade, Maryland (Reserve)

12th Special Forces Group (Airborne), Arlington Heights, Illinois (Reserve)

19th Special Forces Group (Airborne), Draper, Utah (National Guard)

20th Special Forces Group (Airborne), Birmingham, Alabama (National Guard)

112th Special Operations Signal Battalion (Airborne), Fort Bragg, North Carolina

528th Special Operations Support Battalion (Airborne), Fort Bragg, North Carolina

U.S. Army Civil Affairs and Psychological Operations Command (Airborne)

351st Civil Affairs Command, Mountain View, California (Reserve)

352nd Civil Affairs Command, Riverdale, Maryland (Reserve)

353rd Civil Affairs Command, Bronx, New York (Reserve)

96th Civil Affairs Battalion (Airborne), Fort Bragg, North Carolina

2nd Psychological Operations Group, Parma, Ohio (Reserve)

4th Psychological Operations Group (Airborne), Fort Bragg, North Carolina

5th Psychological Operations Group, Washington, D.C. (Reserve)

7th Psychological Operations Group, San Francisco, California (Reserve)

AIR FORCE SPECIAL OPERATIONS COMMAND
1st Special Operations Wing

8th Special Operations Squadron, Hurlburt Field, Florida: MC-130E Combat Talon

16th Special Operations Squadron: Hurlburt Field, Florida: AC-130H Spectre

20th Special Operations Squadron, Hurlburt Field, Florida: MH-53J Pave Low

9th Special Operations Squadron, Eglin AFB, Florida: HC-130N/P Combat Shadow

55th Special Operations Squadron, Eglin AFB, Florida: MH-60G Pave Hawk

39th Special Operations Wing

21st Special Operations Squadron, RAF Alconbury, UK: MH-53J Pave Low

67th Special Operations Squadron, RAF Alconbury, UK: HC-130N/P Combat Shadow

7th Special Operations Squadron, Rhein-Main AB, Germany: MC-130E Combat Talon

33rd Special Operations Wing

Provisional wing formed at Kadena AB, Japan: MC-130E Combat Talon, MH-53J Pave Low, HC-130N/P Combat Shadow

NAVAL SPECIAL WARFARE COMMAND
Naval Special Warfare Center

Located at the Naval Amphibious Base, Coronado, California

Navy Special Warfare Group One

SEAL Teams One, Three, and Five, Coronado, California

SEAL Delivery Vehicle Team One, Coronado, California

Special Boat Squadron One, Coronado, California

Naval Special Warfare Unit 1, Guam

Navy Special Warfare Group Two

SEAL Teams Two, Four, and Eight, Little Creek, Virginia

SEAL Delivery Vehicle Team Two, Little Creek, Virginia

Special Boat Squadron Two, Little Creek, Virginia

Naval Special Warfare Unit 2, Machrihanish, United Kingdom

Navy Special Warfare Unit 4, Roosevelt Roads, Puerto Rico

Naval Special Warfare Unit 8, Panama

Appendix B
AGENCIES SURVEYED

OFFICE OF THE SECRETARY OF DEFENSE

Land Forces Division, General Purpose Programs, Office of the Assistant Secretary of
Defense (Program Analysis and Evaluation), Pentagon

Office of the Director of Net Assessment, Pentagon

JOINT STAFF

Conventional Forces Analysis Division, Director for Force Structure, Resources, and
Assessment (J-8), Pentagon

Politico-Military Assessment Division, Director for Force Structure, Resources, and
Assessment (J-8), Pentagon

Force Design Division, Director for Force Structure, Resources, and Assessment (J-8),
Pentagon

Program Budget and Analysis Division, Director for Force Structure, Resources, and
Assessment (J-8), Pentagon

Joint Warfare Center, Director for Operational Plans and Interoperability (J-7), Hurlburt
Field, Florida

ANALYTIC AGENCIES

Concepts Analysis Agency (Field Operating Agency of the Army Staff), 8120 Woodmont
Avenue, Bethesda, Maryland

Air Force Studies and Analyses Agency (Field Operating Agency of the Air Staff), Pentagon

Center for Naval Analyses (federally funded research and development center responsible to
the Chief of Naval Operations), 4401 Ford Avenue, Alexandria, Virginia

Army-Air Force Center for Low Intensity Conflict (Joint Center responsible to Deputy Chief
of Staff Operations and Plans, the Army Staff, and Deputy Chief of Staff Plans and
Operations, the Air Staff), Langley Air Force Base, Virginia

WAR COLLEGES AND UNIVERSITIES

Center for Strategic Wargaming, U.S. Army War College, Carlisle Barracks, Pennsylvania

Institute for National Strategic Studies, National Defense University, Fort Leslie J. McNair, Washington, D.C.

Air Force Wargaming Center, Air University, Maxwell Air Force Base, Alabama

Wargaming Department, Naval War College, Newport, Rhode Island

Wargaming Center, Marine Corps Combat Development Command, Quantico, Virginia

TRADOC AT LEAVENWORTH

National Simulations Center, Combined Arms Command, Fort Leavenworth, Kansas

Scenario Wargaming Center, Training and Doctrine Command (TRADOC) Analysis Command, Fort Leavenworth, Kansas

Model Directorate, Operations Analysis Center, Training and Doctrine Command (TRADOC) Analysis Command, Fort Leavenworth, Kansas

Appendix C
MODELS SURVEYED

Model	Full Name	Sponsor(s)
ACES	Air Force Command Exercise System	Air University
CASCON III	Computer-Aided System for Analysis of Local Conflicts	Arms Control & Disarmament Agency
Castellon	Castellon (fictitious country)	Harcourt Brace Jovanovich, Inc.
CBS	Corps Battle Simulation	TRADOC-National Simulations Center
CEM	Concepts Evaluation Model	Concepts Analysis Agency
CFAW	Contingency Force Analysis Wargame	Concepts Analysis Agency
CTLS	Current Theater Level Simulation	Concepts Analysis Agency
Eagle	Eagle (symbolic)	TRADOC Analysis Command
ENWGS	Enhanced Naval Wargame System	SPAWAR
Factions	Factions	Yale University (de Mesquita)
FORCEM	Force Evaluation Model	Concepts Analysis Agency
FVC	Force Value Calculator	J8-Force Design Division
ITEM	Integrated Theater Engagement Model	Defense Nuclear Agency
Janus	Janus (Roman two-headed god)	users (Lawrence Livermore National Laboratory)
JCM	Joint Conflict Model	Joint Warfare Center
JTLS	Joint Theater Level Simulation	Joint Warfare Center
Metric VI	Metric VI	BDM International, Inc.
Panther	Panther (symbolic)	NSC, SOUTHCOM
RDSS	Regional Development Simulation System	J8-PMAD (Booz, Allen & Hamilton, Inc.)
RSAS (ITM)	RAND Strategy Assessment System (Integrated Theater Model)	OSD-Net Assessment (RAND)
SEES	Security Exercise Evaluation Simulator	users (Lawrence Livermore National Laboratory)
SOS	Sequence of Strikes	Center for Naval Analyses
SUWAM	Strategic Unconventional Warfare Assessment Model	Joint Warfare Center
TAC RAM	TAC Resource Allocation Model	Air Force Studies & Analyses Agency
Tac Thunder	Tactical Thunder	Air Force Studies & Analyses Agency
TACWAR	Tactical Warfare	J8-CFAD, CENTCOM
TAM	Theater Assessment Model	J8-PMAD
TWSEAS (M)	Tactical Warfare Simulation, Evaluation, & Analysis Model	MCCDC
UCCATS	Urban Combat Computer Assisted Training System	Berlin Brigade (Lawrence Livermore National Laboratory)
VIC	Vector-in-Commander	TRADOC Analysis Command

Hardware/software	Active Users	Uses
Cray, Sun; FORTRAN, C, Motif	AU	gaming
IBM PC or compatible	AWC	seminar games
IBM PC or compatible	AWC	seminar games
VAX; SIMSCRIPT, FORTRAN, C	JWC, NSC	exercises
Cray, Sun, PC; FORTRAN	CAA	force analysis
VAX; FORTRAN	CAA	gaming and analysis
Sun; C Code	CAA	gaming and analysis
Sun; LISP	TRAC	force analysis
VAX; MULTIX-PL1 language	NWC, NPS, fleets	exercises
IBM PC or compatible	CAA	political analysis
VAX, SIMSCRIPT	CAA	gaming and analysis
Excel Spreadsheet	J8-FDD	force analysis
Sun, IBM PC; C++	SHAPE, PACOM	gaming and analysis
VAX; FORTRAN	MCCDC, NSC	gaming and exercises
VAX; FORTRAN	JWC	exercises
VAX; FORTRAN	JWC	exercises
VAX; FORTRAN	BDM	analysis
IBM PC or compatible; PASCAL	NSC, SOUTHCOM	exercises
IBM PC or compatible; iThink	SOUTHCOM	analysis
Sun; C Code, RAND Abel	OSDNA, NDU, AWC, AU, NWC, NPS	analysis and exercises
VAX; FORTRAN	MCCDC	analysis and gaming
VAX; FORTRAN	CNA	analysis
IBM PC or compatible	JWC	gaming and exercises
IBM PC or compatible	AFSAA	force analysis
Sun; SIMSCRIPT	AFSAA, NDU, AU	analysis and gaming
VAX; FORTRAN	OSD PA&E, J8-CFAD, CENTCOM, AWC, TRAC	analysis and gaming
IBM PC or compatible; Ada	J8-PMAD, JWC, CENTCOM, AWC	analysis and gaming
VAX; Ada in TWSEAS (M)	MCCDC, MEF headquarters	exercises
VAX; FORTRAN	Berlin Brigade	analysis and gaming
Sun; SIMSCRIPT	TRADOC Analysis Command	force analysis

Comments
In advanced stage of development; documentation available.
Menu-driven data base drawn from 66 post-WWII conflicts.
Model of presidential decisionmaking in small Latin American country.
Highly interactive exercise driver.
Autonomously run, piston-style simulation based on COSAGE and ATCAL.
Highly interactive hexagon-based theater-level game.
Under development as replacement for CEM and FORCEM.
In advanced stage of development; undocumented.
Highly interactive model of naval operations, tactical-operational level.
Model of interest groups and issues based on expected utility.
Extension of CEM including nuclear exchange.
Decision aid to support base force planning; currently not releasable.
In advanced stage of development; undocumented.
Menu-driven, shooter-level simulation based on kill probabilities.
Taskforce-level simulation derived from Janus.
Highly interactive, hexagon-based theater-level game.
Derived from AF CRES program, hexagon-based, undocumented; BDM sole user.
Hybrid of map exercise and simulation to drive exercises.
Resource allocation model to assess stability of developing countries.
Integrated Theater Model (ITM) currently in development.
Shooter-level simulation designed to evaluate installation security.
Model of carrier air strikes in development at CNA.
Menu-driven simulation of tactical-level events.
Designed to analyze AF force structure; output is ground attack sorties.
Combines AF view of air combat with CEM to produce theater-level model.
Autonomous, piston-style theater-level model using APP methodology.
Highly interactive, piston-style, rapid assessment at theater-level.
Highly interactive driver of amphibious assault exercises.
Improved version of SEES.
Army's corps-level model to support systems analysis.

Appendix D
EVALUATION CRITERIA

The evaluation criteria that produce the model assessment results discussed in Section 7 are listed below. Each criterion is listed with the capabilities necessary for the model to be scored from 0 to 3.

RELEVANCE TO SPECIAL OPERATIONS FORCES

Operational Level of War

1. Measure achieving objective of a campaign:
   0 - Only forces are represented in this model
   1 - Forces and explicit geography are represented
   2 - National entities are implicitly represented
   3 - National entities are explicitly represented

2. Cover an appropriate geographical area:
   0 - This model contains inexplicit geography
   1 - Explicit geography in immediate battle area
   2 - Explicit geography in extended battle area
   3 - Entire theater of operations explicitly represented

3. Represent appropriately sized forces:
   0 - Forces are typically at the weapons/small unit level
   1 - Forces are typically division/squadron/ship
   2 - Forces are typically corps/wing/taskforce
   3 - All theater forces, including support, are represented

Joint and Combined Forces

1. Include land/air/sea forces:
   0 - This model includes only one category of force
   1 - Two categories of force
   2 - Two categories of force and a partial representation of the third
   3 - Three categories of force are included

2. Include heliborne/airborne/amphibious forces:
   0 - This model includes none of these type forces
   1 - One type force included
   2 - Two type forces included
   3 - All three type forces are included in this model

3. Capture synergism of air-land operations:
   0 - This model does not capture the synergism
   1 - Close air support and battlefield interdiction included
   2 - CAS/BAI and some deep targets are included
   3 - Full theater-level array of targets is included

4. Capture synergism of amphibious operations:
   0 - This model does not include amphibious operations
   1 - Administrative landing is modeled
   2 - Isolated opposed landing is modeled
   3 - Opposed landing in the context of the theater of operations is modeled

5. Represent non-U.S. forces with different training levels:
   0 - This model treats forces uniformly
   1 - Scripting possible by country
   2 - Scripting possible by country and force element
   3 - Training levels are explicitly represented

Command, Control, Communications, and Intelligence

1. Represent command structures functionally:
   0 - This model does not represent command structures
   1 - Command structures represented, but not linked to forces
   2 - Some command structures represented, and linked to forces
   3 - All important command structure shown and linked to forces

2. Adjudicate the effects of degraded communications:
   0 - This model does not consider degraded communications
   1 - Broad parameter effects
   2 - Differential parameter effects—e.g., by force type
   3 - Direct link between degraded communications and capabilities

3. Link intelligence collection to combat performance:
   0 - This model does not include intelligence collection
   1 - Broad treatment by parameter
   2 - Explicit collection linked to targeting for one force category
   3 - Explicit collection linked to targeting by more than one force category

Movement and Maneuver

1. Depict the effects of terrain:
   0 - This model does not consider terrain
   1 - Terrain affects movement rates
   2 - Terrain affects movement and maneuver (cover and concealment)
   3 - Terrain affects movement/maneuver and is linked to real world data base

2. Depict worldwide, lift-constrained deployment:
   0 - This model does not simulate strategic deployment
   1 - Includes deployment into the immediate combat area
   2 - Includes deployment into a theater of operations
   3 - Includes deployment into the theater with the depiction of choke points

3. Depict movement of forces within theater:
   0 - This model does not simulate in-theater movement
   1 - Generic ability to script movement
   2 - Explicit movement from ports to combat area
   3 - Explicit movement throughout a theater of operations

4. Consider implications of maneuver:
   0 - This model does not simulate maneuver
   1 - Includes scripted adjudication of flank attack
   2 - Includes explicit adjudication of flank attack
   3 - Includes explicit adjudication of flank attack and envelopment

Unconventional Warfare

1. Depict infiltration and insertion:
   0 - This model does not allow infiltration/insertion
   1 - Scripted infiltration/insertion
   2 - Explicit representation with broad parameters
   3 - Explicit, realistic depiction of infiltration/insertion

2. Depict raiding tactics:
   0 - This model does not allow depiction of raids
   1 - Generic scripting of results of raids
   2 - Explicit simulation of raids
   3 - Explicit simulation including effects on force and non-force targets

3. Effect of popular support on intelligence/recruitment/logistics:
   0 - This model does not consider popular support
   1 - Scripting of some effects is possible
   2 - Parameters are provided to reflect effects
   3 - This model adjudicates effects of popular support

Political, Economic, and Social Factors

1. Consider alignments of countries:
   0 - This model does not allow creation of alignments
   1 - Implicit representation by assignment of forces
   2 - Explicit representation of alignments
   3 - Differentiated attitudes by country—e.g., basing, overflight

2. Consider damage to infrastructure:
   0 - This model does not represent infrastructure
   1 - Possible to script effects of damage
   2 - Generic consideration of effects of damage
   3 - Explicit link between damage and reduced military capability

3. Consider military aptitude and morale:
   0 - This model does not consider aptitude and morale
   1 - Possible to script differences in aptitude and morale
   2 - Parameters are available to reflect differences in aptitude and morale
   3 - Differential adjudication by force type and circumstances

4. Consider popularity of government and opposition:
   0 - This model does not consider relative popularity
   1 - Linkages to combat actions
   2 - Linkages to combat and non-combat actions
   3 - Dynamic modeling of relative popularity

5. Consider allocation of resources:
   0 - This model does not consider resource allocation decisions
   1 - Some allocations implicit in government actions
   2 - Explicit choices affect outcomes
   3 - Dynamic modeling of resource allocations

6. Consider influence of social groups:
   0 - This model does not distinguish social groups
   1 - Social groups are generically represented
   2 - Social groups are explicitly represented
   3 - Social groups are simulated in interactions

ACCEPTANCE

1. Agreement of this model with Service doctrine:
   0 - This model has not been checked against Service doctrine
   1 - Partial agreement with doctrine of one Service
   2 - Full agreement with doctrine of one Service
   3 - Full agreement with doctrine of two Services

2. Correlation with real world events
   0 - This model has not been correlated with real world events
   1 - Informal efforts to correlate this model
   2 - Correlation with at least one real world event
   3 - Correlation with more than one real world event

3. De jure accreditation
   0 - This model has received unofficial accreditation
   1 - Has been reviewed by an appropriate agency
   2 - Has gained official accreditation by one Service
   3 - Has gained official accreditation by two Services or the Joint Staff

4. De facto accreditation
   0 - This model does not have users
   1 - This model receives occasional or limited use
   2 - Wide use within one Service
   3 - Use by more than one Service or the Joint Staff

VIABILITY

1. Technical freshness in language and architecture
   0 - Older language and array-oriented design
   1 - Older language and mixed design
   2 - Older language, object-oriented design or newer language, mixed design
   3 - Newer language and object-oriented design

2. Quality of documentation
   0 - This model is undocumented
   1 - Fragmentary or outdated documentation
   2 - Reasonably complete and current documentation
   3 - Comprehensive and current manuals plus on-line helps

3. Ease in learning the model
   0 - Even with modeling experience, manuals are inadequate
   1 - With modeling experience, manuals are adequate
   2 - Without modeling experience, manuals are adequate
   3 - Without modeling experience, manuals are excellent

4. Ease of new scenario setup
   0 - This model requires over one month for new scenario setup
   1 - One week to one month for new scenario setup
   2 - Up to one week for a new scenario setup
   3 - This model requires one to two days for a new scenario setup

5. Character of human interface
   0 - Typed inputs and file editor
   1 - Menus with helps
   2 - Menus, helps, and data base management tool
   3 - Window environment, menus, helps, and data base management tools

6. Adaptation to global contingency operations
   0 - This model cannot address global contingencies
   1 - Adaptable for combat only
   2 - Adaptable for combat and non-combat operations using work arounds
   3 - Easily adaptable to global contingency operations with explicit representation

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